ZATICS

PUTNAM'S ELEMENTARY SERIES

NATURAL PHILOSOPHY

NATURAL HISTORY.

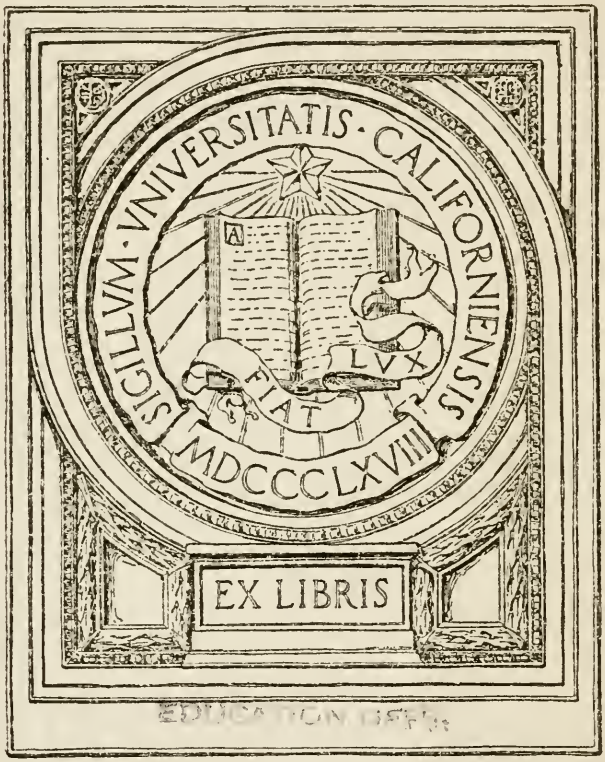
PHYSICAL

GEOGRAPHY

MACTURK

SCIENCE AND ART

CHEMISTRY



F. Beilstein. Translated by William Ramsay, D.Na.Sc.

Extra Volumes, 12mo, cloth.

7B APPLIED MECHANICS. By Henry Evers, LL.D.
15B GENERAL BIOLOGY. By T.C. MacGinley.

ADVANCED SCIENCE SERIES.

Adapted to the requirements of Students in Science and Art Classes and Higher and Middle Class Schools.

Printed uniformly in 12mo, *averaging* 350 *pp., fully Illustrated, cloth extra, Price* $1.50 *each vol.*

1. PRACTICAL PLANE AND SOLID GEOMETRY. By Professor F. A. Bradley, London.
2. MACHINE CONSTRUCTION AND DRAWING. By E. Tomkins, Liverpool.
3. BUILDING CONSTRUCTION. By R. S. Burn, C.E.
4. NAVAL ARCHITECTURE—Laying Off and Shipbuilding. By S. J. P. Thearle, F.R.S.N.A., London.
5. PURE MATHEMATICS. By E. Atkins, Leicester. 2 vols.
6. THEORETICAL MECHANICS. By P. Guthrie Tait, Professor of Natural Philosophy, Edinburgh.
7. APPLIED MECHANICS. By Professor O. Reynolds.
8. ACOUSTICS, LIGHT, AND HEAT. By W. S. Davis, LL.D.
9. MAGNETISM AND ELECTRICITY. By F. Guthrie, B.A., Ph.D., Royal School of Mines, London.
10. INORGANIC CHEMISTRY. By T. E. Thorpe, Ph.D., F.R.S.E., Professor of Chemistry, Glasgow. 2 vols.
11. ORGANIC CHEMISTRY. By James Dewar, F.R.S.E., F.C.S., Lecturer on Chemistry, Edinburgh.
12. GEOLOGY. By John Young, M.D., Professor of Natural History, Glasgow University.
13. MINERALOGY. By J. H. Collins, F.G.S., Falmouth.
14. ANIMAL PHYSIOLOGY. By J. Cleland, M.D., F.R.S., Professor of Anatomy and Physiology, Galway.
15. ZOOLOGY. By E. Ray Lankester, M.A. (Oxon.), London.
16 VEGETABLE ANATOMY AND PHYSIOLOGY. By J. H. Balfour, M.D., Edinburgh University.
17. SYSTEMATIC AND ECONOMIC BOTANY. By J.H. Balfour, M.D., Edinburgh University.
19. METALLURGY. By W. H. Greenwood, A.R.S.M. 2 vols.
20. NAVIGATION. By Henry Evers, LL.D., Plymouth.
21. NAUTICAL ASTRONOMY. By Henry Evers, LL.D.
22. STEAM AND THE STEAM ENGINE—Land, Marine, and Locomotive. By H. Evers, LL.D., Plymouth.
23. PHYSICAL GEOGRAPHY. By John Young, M.D., Professor of Natural History, Glasgow University.

PHYSICAL GEOGRAPHY.

ATLASES OF PHYSICAL GEOGRAPHY.

In Demy 8vo, Stiff Cover, 1s.,

THE PRIMARY ATLAS OF PHYSICAL GEOGRAPHY,

16 Maps, 9 by 11 inches.

In Demy 8vo, Cloth Limp, 2s.,

THE POCKET ATLAS OF PHYSICAL GEOGRAPHY,

16 Maps, mounted on Guards.

In Imp. 8vo, Cloth Lettered, 3s. 6d.,

THE PORTABLE ATLAS OF PHYSICAL GEOGRAPHY.

20 Maps, 11 by 13 inches, mounted on Guards.

In Imp. 8vo, Cloth Lettered, 5s.,

THE STUDENT'S ATLAS OF PHYSICAL GEOGRAPHY,

Twenty Maps, mounted on Guards.

With Letterpress Description and Wood Engravings.

By JAMES BRYCE, LL.D., F.G.S.

Putnam's Elementary Science Series.

PHYSICAL GEOGRAPHY.

FOR USE IN

SCIENCE CLASSES AND HIGHER AND MIDDLE CLASS SCHOOLS.

BY

JOHN MACTURK, F.R.G.S.

Emily L. Swett.

NEW YORK:
GEORGE P. PUTNAM'S SONS,
182 FIFTH AVENUE.

PREFACE.

No effort has been spared to render the present work worthy of its place in a Series of Science Text-Books, that shall be at once popular, accurate, and scientific. It has been thoroughly adapted to the requirements of the Syllabus for Elementary Physical Geography of the Science and Art Department; and every statement has been carefully revised in the light of the most recent and reliable information. By means of Maps, Woodcuts, Diagrams, and descriptive details—so far as was consistent with the limits of the work—it has been attempted to impart perspicuity and interest to the subject. For further information on several points, the student is referred to the Atlases constructed by Mr. E. WELLER, and issued by the Publishers of this work.

In order to render the study as practical as possible, exercises have been freely introduced; but they are by no means intended to supersede careful and minute questioning by the teacher. They are for the most part of a suggestive character, forming in fact an expansion of the text; from which, therefore, they are not in every case capable of being answered directly. They may all,

however, be mastered without difficulty by the intelligent student, with the aid of a little reflection, which they are intended to promote.

For the sake of easy reference, a carefully prepared Index has been added. To familiarise the student with the style of examination to which he may be subjected, recent examination papers of the department have been appended.

J. M.

TILLICOULTRY, *January, 1873.*

CONTENTS.

MAPS.

WOODCUTS.


COMPARATIVE VIEW OF
Amazon 4,500
Mississippi 4,500
La Plata 2,700
Mackenzie 2,160
St. Lawrence 2,140
Madeira 2,000
Orinoco 1,600
Columbia 1,200
Frazer 700
Hudson 300
Gambia 850
Senegal 900
Orange 1,050
Zambesi 2,000
Niger 2,300
Nile 3,000
Volga 2,100
Danube 1,700
Dnieper 1,200
Missouri
Parana
Paraguay
AMERICAN
AFRICAN
E
THE
WESTERN HEMISPHERE
North Pole
ARCTIC OCEAN
ASIA
Greenland
Iceland
Baffin Bay
Davis Strait
C. Farewell
Behring Str.
Behring Sea
Aliaska
Aleutian Is.
Arctic Circle
Hudson Bay
Labrador
Newfoundland
Nova Scotia
DOMINION OF CANADA
NORTH
British Columbia
Vancouver I.
NORTH PACIFIC
NORTH AMERICA
United States
New York
Washington
S. Francisco
Azores or Western Is.
Bermuda
NORTH ATLANTIC OCEAN
Tropic of Cancer
New Orleans
Gulf of Mexico
Bahama Is.
Cuba
Hayti
West India Is.
C. Verde Is.
Sandwich Is.
Hawaii
C. S. Lucas
Mexico
Jamaica
Caribbean Sea
Marshall Is.
Central America
Orinoco R.
Venezuela
Guiana
OCEAN
Panama
New Granada
Amazon
Gilbert Is.
Ecuador
Maranhao
Equator
Galapagos Is.
C. Blanco
C. S. Roque
SOUTH AMERICA
Ellice Is.
Marquesas Is.
Peru
Brazil
Pernambuco
Solomon Is.
Navigators Is.
Society Is.
Tahiti
Low Archipelago
Lima
Bahia
POLYNESIA
New Hebrides
Feejee Is.
Friendly Is.
Cook Is.
Tropic of Capricorn
Easter I.
Bolivia
Paraguay
Trinidad
Pitcairn I.
New Caledonia
Austral Is.
Juan Fernandez
La Plata
Rio Janeiro
SOUTH PACIFIC OCEAN
Santiago
Uruguay
Norfolk I.
Buenos Ayres
R. de la Plata
New Zealand
North I.
Wellington
Chatham I.
Nelson
South I.
Dunedin
Stewart I.
Antipodes I.
Patagonia
Tierra del Fuego
Falkland Is.
C. Horn
S. Shetland
Georgia
Antarctic Circle
Graham Ld.
S. Orkney
ANTARCTIC OCEAN
South Victoria
South Pole
Aconcagua 23,910
Chimborazo 21,424
Illimani 21,149
Antisana 19,137
Cotopaxi 18,875
Orizaba 17,400
Pichincha 16,000
Agua 15,000
St. Elias 17,000
Brown 16,000
Fairweather 14,700
Fremonts Pk. 13,570
Mt. Hood 12,000
ROCKY Mts.
Sa. del Cobre Cuba 9,000
Blue Mts. Jamaica 7,400
Parime Mts. highest 10,000
Alleghany Mts. highest 7,000
Sierra do Frio 5,830
Cape Horn 1,870
AMERICAN
Mt. Blanc 15
Cervin 14,837
Gothard 12,975
Pyrenees 11,000
Dovrefeld 8,000
Mt. D'Or 6,700
Kolen 5,000
Puy de Dome 4,750
Hecla 3,970
Harz 3,670
Helvellyn
Scafell
Skiddaw
Wicklow Mts.
Mourne Mts.
Mangerton
Cheviot
EUROPE
COMPARATIVE VIEW OF

E PRINCIPAL RIVERS

Rhine 500	Duina 900	Elb. 800	Vistula 628	Seine 500	Tagus 300	Shannon 212	Thames 200	Tweed 113	Tay 80	Irrawady 1,200	Ganges 1,800	Euphrates 1,200	Indus 1,600	Amoor 2,500	Lena 2,140	Obi 2,550	Hoang Ho 2,550	Yenisea 2,500	Yang tse kiang 3,200

R O P E A N A S I A T I C

ORLD.

EASTERN HEMISPHERE

E PRINCIPAL MOUNTAINS

Himalaya Mounts
Taurus 13,000
Lebanon 15,000
Ararat 17,712
Sinai 7,500
Atlas 5,000
Pyrenees 9,000
Alps 15,000
Apennines 9,500
Balkan 9,500
Carpathian 8,500
Ural 5,000
Table Mt. 3,582

PHYSICAL GEOGRAPHY.

INTRODUCTION.

Physical Geography is that department of Geography which relates to the great natural features and arrangements of the globe. It treats of:

(1) The **Land**, as to its extent, distribution, configuration, and structure;

(2) The **Waters**, as to their extent, distribution, configuration, composition, and movements;

(3) The **Atmosphere**, as to its composition, currents, vapours, and temperature, and therefore climate; and,

(4) The **Distribution of Animal and Vegetable Life.**

FORM, SIZE, AND MOTIONS OF THE EARTH.

Form of the Earth.—The form of the Earth is nearly that of a globe or sphere—not being perfectly round, but compressed or flattened on two opposite sides, somewhat like an orange.

Such a figure is termed an *oblate* spheroid.

The inhabitants of the globe, on the opposite side from us, have their feet turned towards ours, and are therefore termed *Antipodes*.

Proofs of the Earth's Rotundity.—(1) Our circle of vision becomes wider the greater the elevation of our position on the earth's surface.

(2) The tops of masts, towers, and mountains are, on approaching them, first observed, and afterwards the lower portions.

(3) In travelling a great distance north or south, new stars appear in view in advance, while others disappear behind us.

(4) In circumnavigating the globe, navigators sailing due west or east, arrive at their point of departure.

(5) The shadow of the earth upon the moon during an eclipse is always round.

(6) In making a canal, allowance must be made for a dip of eight inches in each mile to keep the water at a uniform depth.

Size of the Earth.—The mean diameter of the Earth is 7912 miles (or nearly 8000 miles)—the Equatorial, or larger diameter, being 7925 miles, and the Polar, 7899.

If the Equatorial diameter were divided into 300 equal parts, the Polar diameter would measure 299 of them; that is, it is $\frac{1}{300}$ shorter. In an artificial globe of 18 inches diameter, this deviation from the spherical form would amount to about $\frac{1}{17}$ part of an inch.

The **Circumference** of the Earth is 24,856 miles (or nearly 25,000 miles); the **Area**, or superficial content, 197,000,000 square miles; the **Volume**, or solid content, 260,000,000,000 cubic miles; and the **Weight**, 5,425,092,500,000,000,000,000 tons.

Motions of the Earth.—The Earth has three motions:—

(1) The **motion through space** along with the rest of the Solar System.

(2) Its **annual motion**, or revolution round the Sun in about $365\frac{1}{4}$ days.

(3) Its **diurnal motion**, or rotation on its own axis, in about 24 hours.

The Earth's motion round the Sun causes the changes of the seasons and the difference in the length of day and night: its motion on its own axis causes the apparent rising and setting of the Sun, or the alternation of day and night.

The **Earth's Orbit**, or path round the Sun, is about 184,000,000 miles in mean diameter, and 565,000,000 in circumference. Its form is not a circle, but rather an ellipse, so that the earth is not equally distant from the sun at all periods of the year; its perihelion, or nearest point, being at the beginning of the year, or northern winter, and its aphelion, or farthest point, about the middle of the year, or northern summer. As the difference is only about 3,000,000 miles, it has no perceptible influence on the degree of solar heat, which is greatest in summer, when the sun is most nearly vertical, and least in winter, when his rays fall more slantingly on the earth.

DEFINITIONS.

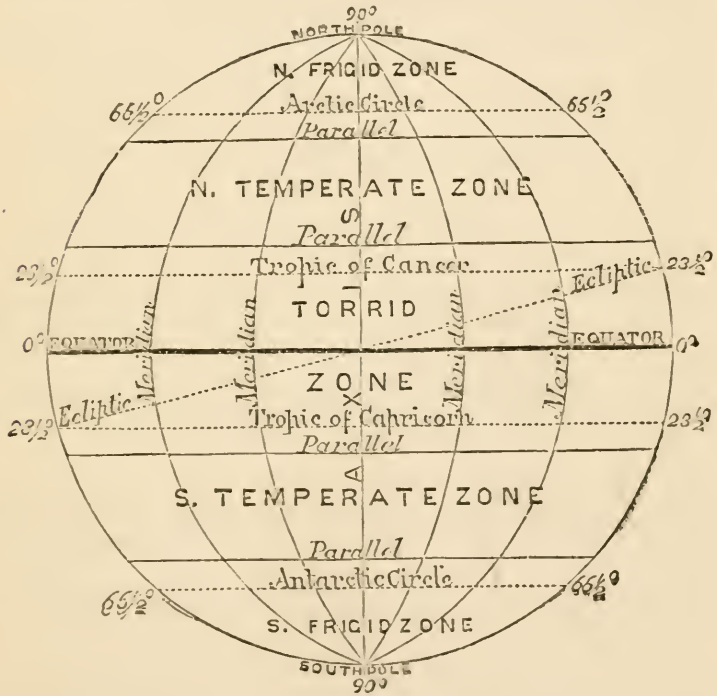
MATHEMATICAL DIVISIONS OF THE EARTH.

The **Axis** of the earth is an imaginary line which passes through its centre, and round which it rotates daily.

The **North and South Poles** are the extreme points of the Axis.

The **Equator** is a great circle passing round the middle of the earth, at an equal distance from the Poles.

A **Hemisphere** is one-half of the earth considered as a globe or sphere.



MATHEMATICAL DIVISIONS OF THE EARTH.

The **Meridians** are great circles passing round the earth at right angles to the Equator, and cutting each other at the Poles.

A **Semi-Meridian** is that half of a Meridian which terminates in the Poles.

The Northern and Southern Hemispheres are formed by the Equator; the Eastern and Western Hemispheres by Meridians.

Latitude is the distance of a place north or south of the Equator.

Longitude is the distance of a place east or west of any given semi-meridian.

Longitude is reckoned by the British from the semi-meridian of Greenwich, which is, on that account, called the First Meridian.

Parallels of Latitude are lines drawn parallel to the Equator, and are used to indicate latitude.

The **Tropics** are two remarkable Parallels of Latitude, viz.:

The Tropic of Cancer, nearly $23\frac{1}{2}°$ north of the Equator;
The Tropic of Capricorn, nearly $23\frac{1}{2}°$ south of the Equator.

The **Polar Circles** are two remarkable Parallels of Latitude, viz.:

The Arctic Circle, nearly $23\frac{1}{2}°$ from the North Pole;
The Antarctic Circle, nearly $23\frac{1}{2}°$ from the South Pole.

The **Ecliptic** is a great circle, cutting the Equator at two opposite points at an angle of nearly $23\frac{1}{2}°$, and reaching the Tropics as its extreme limits north and south. It represents the sun's apparent path through the heavens in the course of a year; but in reality the path of the earth round the sun.

The **Equator, Ecliptic, Meridians,** and **Parallels,** are not real, but imaginary, lines on the earth's surface, and are drawn on maps and artificial globes for convenience in determining the position of places.

The **Zones** are Five Great Belts into which the earth is divided by the Tropics and the Polar Circles, viz:

The **Torrid Zone,** between the Tropics;

Two Temperate Zones, between the Tropics and the Polar Circles;

Two Frigid Zones, between the Polar Circles and the Poles.

Characteristics of the Zones.—The Zones are chiefly distinguished by their climatic differences:—

The **Torrid Zone**, so called from its *scorching* heat, has the sun vertical twice in the year, the days and nights differ little in length throughout the year, and vegetation is most luxuriant.

The **Temperate Zones** have a milder or *temperate* climate, the sun never being vertical, the days and nights are more unequal, the four seasons are more distinct, and the productions of the earth less rich and exuberant than in the Torrid Zone.

The **Frigid Zones**, so called from their extreme cold, have one long intensely cold winter, when for several weeks the sun never rises, and one short hot summer, when for several weeks the sun never sets (the period being longer or shorter at different places according to the latitude). Vegetation is scanty and stunted.

Comparative Areas of the Zones.—Suppose the entire surface of the earth divided into 100 equal parts :

The Torrid Zone would be	=	40 parts.
Two Temperate Zones, each 26,	=	52 ,,
Two Frigid Zones, each 4,	=	8 ,,
		100

NATURAL DIVISIONS OF THE EARTH'S SURFACE.

Land.

A **Continent** is a large continuous extent of land comprising several countries.

An **Island** is a smaller portion of land than a continent, and is wholly surrounded by water.

An **Archipelago** consists of several groups or clusters of islands.

"The Archipelago" is the name applied to the *Sea* between Greece and Asia Minor, and not to the islands contained in it.

A **Peninsula** is land almost wholly surrounded by water.

An **Isthmus** is a narrow neck of land joining two larger portions of land together.

A **Cape** is a point of land stretching out into the water.

A Cape is also called a Promontory, Point, Head, Headland, Mull, Naze, or Ness.

A **Coast** or **Shore** is the margin of land washed by the sea.

The **Sea-Board** is the strip of country bordering on the sea.

A **Mountain** is a mass of land raised considerably above the surrounding surface.

A **Hill** is a lower elevation than a Mountain.

A **Mountain Chain**, or **Range**, is a continuous line of Mountain heights.

A **Group** of Mountains consists of a number of heights or ranges, more or less connected.

A **Mountain System** consists of a series of Mountain Chains or Groups.

A **Volcano** is a Mountain which casts forth smoke, flames, ashes, lava, etc.

A **Valley** is a hollow or low land lying between Mountains or Hills.

A **Plain** is a flat extent of land not much raised above the level of the ocean.

A **Plateau** or **Table-Land** is a plain considerably elevated above the level of the ocean.

A series of Plains at different levels are named **Terraces**.

Plains have received specific names in different parts of the world; as, **Prairies** and **Savannas**, in North America; **Pampas**, **Llanos**, and **Selvas**, in South America; **Steppes**, in the south-east of Europe and the north-west of Asia.

Water.

The **Ocean** or the **Sea** is the general name applied to the great continuous expanse of salt water which surrounds the globe.

An **Ocean** is one of the five large divisions of the waters of the globe.

A **Sea** is a smaller body of salt water than an ocean, and more or less detached from it.

Inlet is the general name for all openings or indentations of the sea-coast.

A **Gulf** is a portion of water running into the land, and having a narrow opening.

A **Bay** is a portion of water running into the land, but having a wider opening than a gulf.

The terms *Gulf* and *Bay* are frequently misapplied—the one being used for the other.

Roads or Roadstead is a place where ships may be moored at some distance from the land.

A Harbour or Haven is an inlet where ships may be moored and obtain shelter.

A Creek is a small inlet on a low coast. In Australia and America it means a small inland river.

A Strait or Sound is a narrow passage of water uniting two larger portions of water.

A Channel is a wider passage than a Strait.

A Bank is elevated ground at the bottom of the sea, and rising to near the surface.

Banks are also termed Flats, Shoals, Shelves, or Shallows; if at the surface, they are termed Reefs; if above the surface, they would form islands.

A Lake is a body of water surrounded by land.

A Lagoon is a shallow lake formed on low lands by the overflow of rivers or the sea.

A River is a considerable stream of fresh water running through the land into the sea, a lake, or another river.

A Rivulet or Brook is a small stream of water.

A Tributary or Affluent is a river that falls into another river.

The Confluence is the point where two rivers meet.

The Source of a river is the place where it rises.

The Mouth of a river is the place where it empties itself.

An Estuary or Firth is the mouth of a river widening into an arm of the sea.

The Banks are the portions of land bordering on each side of a river. The right and left banks are those to the right and left of a person looking down the river.

The Bed of a river is the channel which contains its waters.

The Basin of a river is that portion of country which is drained by the river and all its tributaries.

A Watershed is the ridge or elevated land which separates one river-basin from another.

A River-System consists of all the river-basins inclined to any particular sea or ocean.

A Delta is a low tract of alluvial land deposited at the mouths of certain rivers, and dividing them into two or more streams; so called from its resemblance to the Greek letter Δ, named "delta."

CHAPTER I.

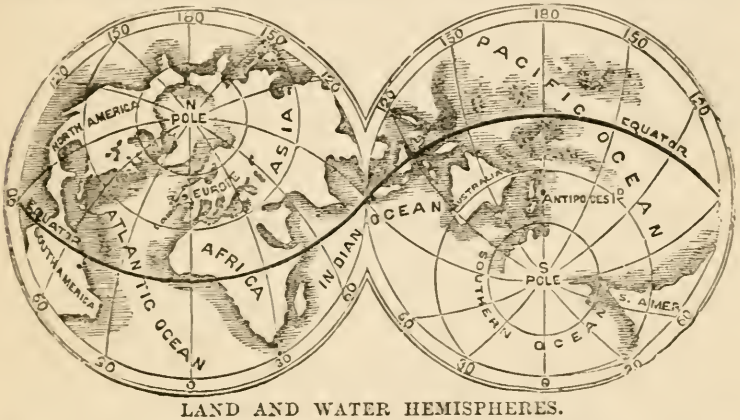
DISTRIBUTION OF LAND AND WATER.

General Aspect—Relative Proportions—Configuration of the Land (Horizontal)—Points of Resemblance—Coast Lines—The Island System.

1. **General Aspect.**—On glancing at the map of the world, or at a terrestrial globe, we cannot fail to observe the very unequal extent and distribution of the land and sea which occupy its surface. Surrounding the globe on all sides, we find one vast continuous expanse of water, with two large continental masses of land emerging from its bosom, and a great many smaller ones scattered over it, either isolated or grouped into archipelagoes. These two great continents at the Arctic Circle approach to within 36 miles of each other, and then recede respectively in a south-easterly and south-westerly direction, till they reach points far into the southern hemisphere, with three-fourths of the earth's circuit between them. The latter of these, called the **Eastern Continent**, from being commonly projected upon the Eastern Hemisphere, or the **Old World**, as being the only one known to the ancients, extends in a direct line between these two extreme points, a distance of 11,000 miles; whilst the former, styled the **Western Continent**, or **New World**, stretches upwards of 9,000 miles, or more than one-third of the circumference of the globe. To the south-east of Asia appears the vast island or continent of **Australia**, forming the nucleus of that great island-system of the southern seas which has been termed **Australasia**; but the whole island-world lying east of the Old World, and west of the New, is known by the name of **Oceania**.

2. **Relative Proportions.**—The entire area of the globe is nearly 197 millions of square miles. Of this about 145 millions are water, and 52 millions land; or about $^3/_4$ water, and $^1/_4$ land. Considered in hemispheres, the land

of the Eastern is about $2\frac{1}{2}$ times that of the Western; while the land of the Northern Hemisphere is about 3 times that of the Southern. If we compare the different zones, we find the land most largely developed in the North Temperate Zone,—forming more than $\frac{1}{2}$ of the whole area; while that of the Torrid Zone forms no more than $\frac{1}{3}$. The great belt of the North Temperate Zone, embracing the better portions of Asia, Europe, and North America, has proved the most favourable to the development and progress of the human race, and is the great track along which civilization has hitherto advanced.



LAND AND WATER HEMISPHERES.

But so unequally distributed are the land and water, that not more than $\frac{1}{27}$ of the whole land surface of the globe has land for its antipodes, and at the Equator only $\frac{1}{6}$ of the whole circumference is composed of land. In fact, if we divide the globe into two hemispheres—the one having London as its centre,* and the other Antipodes Island,

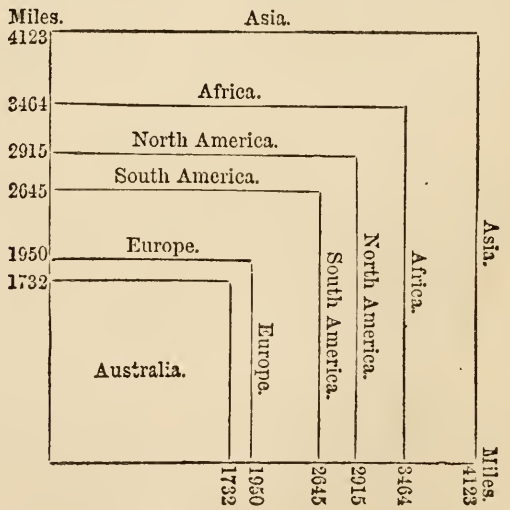
* London is not the exact centre of the Land Hemisphere, but a spot near the middle of St. George's Channel. But this position of London, in the very centre of the nations may serve not a little to explain its greatness and commercial prosperity, and to indicate its apparent destiny as a centre of influence to the world. For the same reason, the ports of the adjoining shores have also become the great rendezvous of nations, and the busy marts of commerce.

near New Zealand—the former will embrace $^9/_{10}$ of all the land, and the latter will be nearly all ocean.

SIZE OF THE CONTINENTS (INCLUDING ISLANDS.)

	Greatest Length.	Greatest Breadth.	Area in Sq. Miles.*	Comparative Size.
Europe,	3,400 M.	2,450 M.	3,800,000	1†
Asia,	6,700 ,,	5,400 ,,	17,000,000	$4\frac{1}{2}$
Africa,	5,000 ,,	4,600 ,,	12,000,000	$3\frac{1}{5}$
(OLD WORLD),	...	...	(32,800,000)	...
N. America,	5,600 ,,	3,120 ,,	8,500,000	$2\frac{1}{4}$
S. America,	4,500 ,,	3,000 ,,	7,000,000	2
(NEW WORLD),	...	...	(15,500,000)	...
Oceania,	10,000 ,,	5,000 ,,	4,500,000	$1\frac{1}{5}$
Australia,	2,500 ,,	2,000 ,,	3,000,000	$\frac{5}{6}$

COMPARATIVE VIEW OF THE AREAS OF THE CONTINENTS, REDUCED TO SQUARES.



* The areas are given in round numbers.
† Take Europe as the standard of comparison.

CONFIGURATION OF THE LAND (HORIZONTAL).

3. Points of Resemblance.—(1) Whilst the mass of the land in the Northern Hemisphere lies, for the most part, parallel with the equator and along the great zones, —its greatest extension being along the 50th parallel,— it sends forth three great prolongations to the south: viz., South America, Africa, and Australasia—considering the last as a continuation of Asia partly submarine.

(2) All these great divisons of the land extend in broad, unbroken, compact masses in the north, but taper gradually to the south, assuming generally a triangular form. The northern shores, running nearly in a line along the 70th parallel, and almost girdling the world, are flat and low; the southern, sundered by great oceans, are sharp and elevated.

(3) The same analogy subsists with regard to the *leading* peninsulas of the world, which all run to the south, with the exception of Yucatan in Central America, Jutland in Europe, and a few others. The latter are low and sandy; the former are mostly high and rocky.

(4) Most of the peninsulas have an island, or group of islands, near their extremities, lying frequently to the south-east. Thus, South America and Africa (which are just peninsulas on a gigantic scale) have respectively Tierra del Fuego and Madagascar;* Florida has the West Indian Archipelago, and Malacca the East Indian; Italy has Sicily; India, Ceylon; and Australia, Tasmania.

(5) The three great peninsulas of Europe bear a general resemblance to those of Asia: viz., the Iberian peninsula to the Arabian; Italy, along with Sicily, to India with Ceylon; and Greece with its archipelago, to Malacca with the East Indian Islands. A similar analogy

* Immediately to the south of the Cape of Good Hope is L'Agulhas Bank, which may be regarded as really an island, but not appearing above the water.

may be traced between Mexico and India, Florida and Malacca, the West Indies and the East Indies.

(6) Nearly the same meridians cut the extreme north and the extreme south points of the great continents: with this view compare Cape Horn with the north-east end of Cockburn Island, Cape of Good Hope (as well as Cape Matapan) with the North Cape, Cape Romania with Cape Severo.

(7) Africa and South America have a very striking similarity in their position and outline, so as to seem the counterparts of each other, as if they had originally formed one mass and been parted by some great agency. The western projection in the north of Africa would fit into the great aperture on the opposite shore of the Atlantic formed by the Caribbean Sea, while the projecting part of South America would fit equally well into the Gulf of Guinea.

4. **Coast-Lines.**—While the northern continents throw out numerous arms into the ocean, and are in return penetrated by numerous gulfs, bays, and inland seas, the southern continents, viz., South America, Africa, and Australia, present each a solid compact mass,—their uniform and unbroken coast-line shutting out the advances of the ocean. Asia on the south and east projects the large peninsulas of Arabia, Hindostan, Farther India, the Corea, and Kamtchatka, with China and Manchooria, which together form $1/5$ of its whole land-surface. Europe, whilst itself only a peninsula of Asia, is subdivided repeatedly into secondary peninsulas, so that $1/4$ of its whole mass is presented under that form; while land and sea are so interlaced that, except in the east of Russia, no place is more than 500 miles from the coast. It is, therefore, of all the continents, the most accessible, and, consequently, the most favourably situated for commerce and navigation, and the development of its internal resources. North America, especially on its east coast, partakes of the same characteristic features, but to a more limited extent.

The possession of a deeply-indented, and therefore an extended, coast-line, has a most important bearing upon the climate, and, therefore, upon the productions of a country, as well as the health and character of the inhabitants. To the facilities it has afforded to the enterprise of Europe and North America, which excel the other continents in the comparative length of their coast-line, may be ascribed much of their pre-eminent wealth, power, and civilization.

TABLE OF COAST-LINES.

	Miles of Coast-Line.	Sq. Miles for 1 Mile of Coast.	Comparative Length of Coast.
Europe,	17,000	225	1*
Asia,	35,000	486	$\frac{1}{2}$
Africa,	16,000	750	$\frac{3}{10}$
N. America,	24,000	354	$\frac{2}{3}$
S. America,	13,600	515	$\frac{3}{7}$
Australia,	7,600	395	$\frac{3}{6}$

5. The Island System.—The island masses differ from the continental only in respect to size, being, in fact, for the most part, continents in miniature. They are portions of the same solid substance of the globe, rising from the floor of the ocean, but their inferior elevation permits only a smaller surface to protrude. Groups and chains of islands are generally the crests of mountains whose bases are at the bottom of the ocean. Australia is so large as to be frequently called a continent—being little inferior to Europe. Some are so small as to be only a few square yards in extent, uninhabited, and scantily clothed with soil and vegetation. Others, again, are so low as to be mere sandbanks, ledges of rock, or coral reefs. The larger ones are nearly all contiguous to the continents, to which, in their geological structure and the direction of their mountain system, they bear so close a relationship as to be considered nearly detached portions

* Take Europe as the standard of comparison

or submarine prolongations. These are called **continental** islands. The smaller ones, either solitary or in groups, are in general dispersed over the oceans, and at great distances from the mainland. These are the **oceanic** islands, and are either of volcanic origin, like St. Helena and Ascension, or of coralline formation, like the thousands of islets of Polynesia. The most important archipelagoes or island-groups are the **British, Japanese, East Indian, West Indian, and Grecian**; whilst the vast assemblage of island-forms that stud the wide expanse of the Pacific, has nowhere else a parallel. The largest individual islands (not including Australia) are :—

Greenland,	380,000 sq. miles.	Sumatra, .	177,000 sq. miles.
Borneo, .	280,000 ,,	Niphon, .	109,000 ,,
New Guinea,	274,500 ,,	Great Britain,	88,828 ,,
Madagascar,	234,000 ,,		

But taken together, the whole island-masses form no more than about $1/20$ of the whole land area of the globe.

EXERCISES.

1. Name the extreme southern points of the great continents and Australasia. How far are they from the Antarctic Circle, and from each other? Give the direct distances (approximately) from East Cape to Cape of Good Hope and to Cape Horn. Given the area of a sphere = diameter$^2 \times 3{\cdot}1416$, and the mean diameter of the globe = 7912 miles; supposing the earth a perfect sphere, find its area. Name the countries or islands which have lands for their antipodes. Point out the meridians of most land and least land. Name the countries not included in the land hemisphere. Compare the area of each of the Continents with that of the British Islands, (122,000 sq. m.)

2. Name the countries along the 50th parallel. What islands most nearly connect Australia with Asia? Write out in tabular form the leading peninsulas of Europe, Asia, Africa, North America, and South America. Name a peninsula in Europe running west—one in Asia—one in America. Give other examples of islands situated near the extremities of peninsulas. What are the meridians that most nearly cut the extreme north and south points of the great continents? Write out in your

own words the leading points of resemblance in the outlines of the land.

3. Draw two lines that would cut off all the peninsulas of Asia on the south and east. Point out two peninsulas on the north of Asia. Name those peninsulas of Europe that are most subdivided. Which parts of North America are most indented? Arrange in order the continents according to extent of coast-line. Give a comparative view of the comparative length of coast-lines by means of a scale, or otherwise. What two islands in the Atlantic are most distant from the mainland and from others? and how far? Write out a descriptive account of the Distribution of the Land.

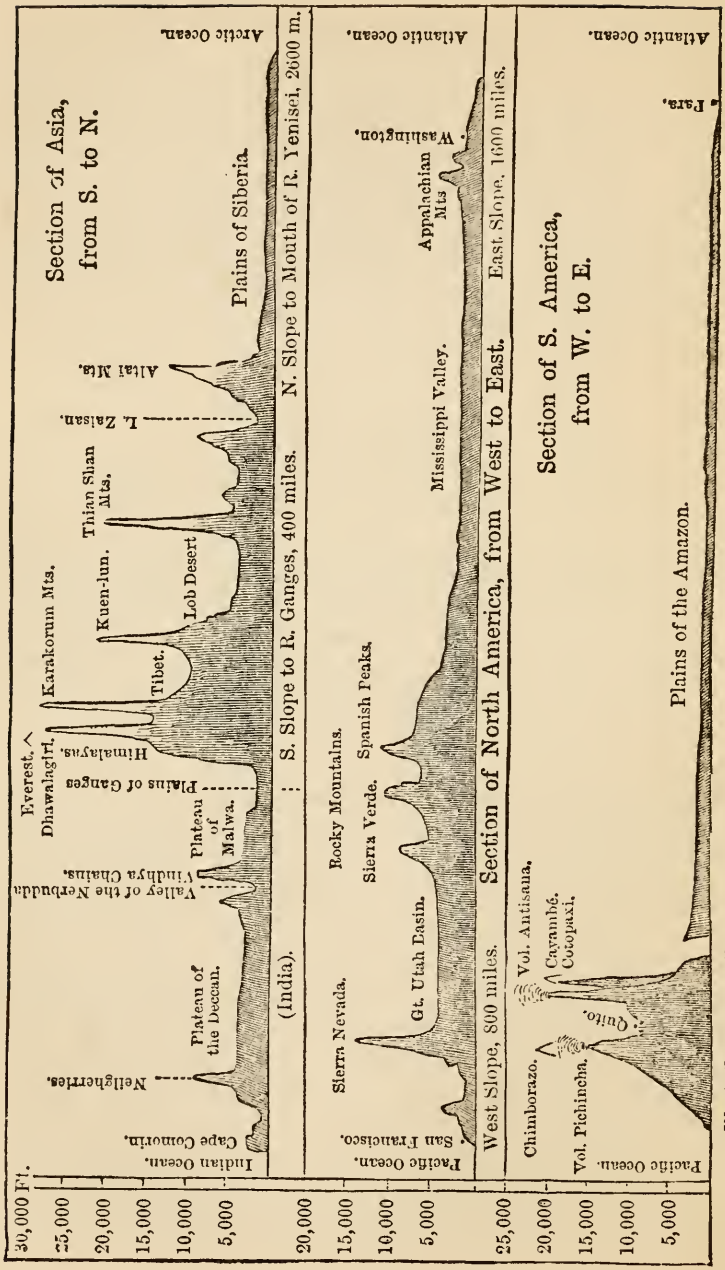
CHAPTER II.

VERTICAL CONFIGURATION OF THE LAND.

Forms of Vertical Arrangement—Laws of Vertical Arrangement—Configuration of Mountains—Mountain Chains—Dimensions of Principal Mountain Chains—Height of Mountains—Hills—Uses of Mountains—Principal Mountains of the Globe—Table-Lands or Plateaux—The Sahara—Principal Plateaux—Lowland Plains—Steppes, etc.—Prairies—Llanos—Pampas—Uses of Plains—Principal Plains—Valleys—Mean Elevation of the Continents.

6. Forms of Vertical Arrangement.—The land-masses are not disposed at one uniform level, but assume various forms and elevations. There are the low flat **polders** of Holland just reclaimed from the sea, and with difficulty retained from it; river **deltas**, as of the Nile and Ganges, where, in the swimming marsh, the contending elements of sea and dry land are intermingled; **lowland plains**, flat or undulating, and but little raised above the level of the sea; elevated **plateaux** or highland plains; and **mountain ranges**, with their cloud-capt peaks and snow-clad summits.

Although, to the casual observer, these mountains and valleys, plains and plateaux, may appear to be without order or regularity, yet a more careful examination will


Section of Asia, from S. to N.
30,000 Ft.
25,000
20,000
15,000
10,000
5,000
Indian Ocean.
Cape Comorin.
Nellgherries.
Plateau of the Deccan.
Valley of the Nerbudda
Vindhya Chains.
Plateau of Malwa.
Everest.
Dhawalagiri.
Himalayas.
Plains of Ganges
Karakorum Mts.
Tibet.
Kuen-lun.
Lob Desert
Thian Shan Mts.
L. Zaisan.
Altai Mts.
Plains of Siberia.
Arctic Ocean.
(India).
S. Slope to R. Ganges, 400 miles.
N. Slope to Mouth of R. Yenisei, 2600 m.
Section of North America, from West to East.
West Slope, 800 miles.
East Slope, 1600 miles.
Pacific Ocean.
San Francisco.
Sierra Nevada.
Gt. Utah Basin.
Rocky Mountains.
Sierra Verde.
Spanish Peaks.
Mississippi Valley.
Appalachian Mts
Washington.
Atlantic Ocean.
Section of S. America, from W. to E.
Chimborazo.
Vol. Pichincha.
Vol. Antisana.
Cayambé.
Cotopaxi.
Quito.
Plains of the Amazon.
Para.
Pacific Ocean.
Atlantic Ocean.
West Slope, 100 miles.
East Slope, 1850 miles.

show us a few great general principles presiding over their arrangement.

7. Laws of Vertical Arrangement of the Land.—(1) *The continents rise gradually from the shores of the ocean into the interior to some line or ridge of greatest elevation.*

These slopes may be easily discovered by casting the eye upon the map, and following up the great river-courses; the ridge along which they rise is the line of greatest elevation. To this law there are only two well-ascertained exceptions, and they are remarkable. The one is an extensive region around the Caspian Sea and Lake Aral, with an area of 162,000 square miles (five times the size of Ireland), which forms so great a depression that the surface of the Caspian, which is its lowest point, is 83 feet below the sea level; the other is the basin of the Dead Sea, the surface of which is 1312 feet below the Mediterranean.

(2) *The line or axis of greatest elevation is placed, not in the centre, but nearer to one side of the continents.*

The two great slopes of the land thus formed are, in consequence, of unequal length and inclination: the one long and gentle, the other short and steep. The long slope is, on an average, four or five times the length of the other. In the Old World, the long slope is to the north; in the New World, to the east.

Thus, from the Himalayas, the highest ridge of Asia, to the Frozen Ocean, at the mouth of the Yenisei, is a length of 2600 miles, but south to the Plains of Hindostan it is only 400; from the Alps to the Baltic is 450 miles, but south to the Plain of Northern Italy is only 100; from the Rocky Mountains to the Atlantic the eastern slope is 1600 miles, while the western slope to the Pacific is 800; and while from Chimborazo, in the Andes of South America, eastwards to the mouth of the Amazon, the distance is 1850 miles, to the Pacific westwards it is less than 100.

If we consider the Northern Ocean as an extension of the Atlantic, so as to form with it one great basin, and the Indian Ocean as but a portion of the basin of the Pacific, the long slope is turned towards the Atlantic

basin and the short slope to the Pacific. It would seem as if the land-mass bordering on the latter had been tilted up, so as to throw the waters off chiefly to the other side. The loftiest mountains in the world surround the margin of this mighty basin like a hem: near its eastern border a great chain rises abruptly along its whole extent of 9000 miles, is continued through the Aleutian Isles into Central and Southern Asia, finds its way by the highlands of Arabia into Africa, and thence southwards along the coast to the Cape of Good Hope. An immense number of active volcanoes blaze around this extensive margin, from Tierra del Fuego ("Land of Fire") to Mount Erebus in South Victoria Land.

(3) *The grand linear elevations, or mountain chains, extend in the line of the greatest length of the continents.*

In other words, the general direction of the mountains determines that of the land; for mountains are the skeleton of the lands, and determine their figure and outline as truly as the bones do those of an animal. The great series of mountain ranges which forms the line of greatest elevation, is the backbone of the continents. Secondary ranges of inferior elevation branch off at various angles from the main axis; and it is such chains that are chiefly concerned in the formation of our leading islands and peninsulas. They are the ribs and limb-bones in the great framework of our planet.

In the Old World, whose greatest length is from east to west, or along the parallels, an almost unbroken series of ridges stretches in the same general direction between their extreme points. From Cape St. Vincent to Behring's Strait (not mentioning inferior elevations) the connection is maintained by the successive ranges of the Sierra Morena, the Pyrenees, the Alps, the Balkan, Taurus, Elburz, Hindoo Koosh, Bolor Tagh, the Altaï, Yablonoi, Stanovoi, and Aldan Mountains. In the New World, again, whose greatest length is from north to south, the mountains also follow the meridians—the Rocky Mountains and the Andes being the chief ranges of that series that stretches uninterruptedly from Behring's Strait to Cape Horn. The Alleghanies and Cordilleras of Brazil preserve the same general direction. The mountains of Africa, so far as certainly known, appear to follow the direction

of the coast-line; and the same may be said of the mountains of Australia. And as with the continents, so with the chief islands and peninsulas: Scandinavia is traversed through its entire length by the Scandinavian Alps, Italy by the Apennines, India by the Ghauts, and similarly Madagascar, Japan, etc.

(4) *The greatest elevations are in the south of the continents, there being a gradual rise from the Arctic Circle, where the lands are lowest and flattest, on to the tropical regions.*

The culminating point of the Old World (Mount Everest) is situated near the Tropic of Cancer, whilst that of the New World (Aconcagua in Chili) is not far south of the Tropic of Capricorn. As, according to a well-known law, temperature is diminished by elevation, the lowness of the northern surface serves to mitigate the rigours of the Arctic climate, and the highlands of the south temper the fierceness of the tropical heat. "If this order were reversed, and the elevation of the lands went on increasing towards the Poles, the most civilized half of the globe at the present day would be a frozen uninhabitable desert."

MOUNTAINS.

8. Configuration of Mountains.—Mountains are the grandest and most sublime objects on the surface of the globe. They present every variety of outline and appearance: they have gently sloping declivities, rounded summits, and broad massive shoulders; or they are serrated with splintered peaks, terraced by crags, piled up like gigantic battlements, or towering into cones, domes, and pyramids. In their more familiar forms they may be clothed with rich green pastures, or embrowned with purple heaths; but their grander developments, leaving the realms of vegetation, tower high into the desolation of eternal snows. And this external aspect maintains a close correspondence with their internal structure. The practised eye of the geologist can generally determine from their outline the character of their rocky formations —the bald and massive forms of granite, the black,

gloomy walls of trap and basalt, the abrupt splintered pinnacles of schist and quartz, the round undulations of chalk, and the isolated cones of volcanoes.

9. Mountain Chains.—It is rare that a mountain rises from the plain in complete isolation from others; and when this does occur, it is chiefly in the case of heights of volcanic origin. Among the more remarkable examples of this class are Mount Egmont, in New Zealand, and the Peak of Teneriffe in the Canary Islands. The most common arrangement is that of chains, frequently consisting of several parallel ridges, the centre one being the highest. These chains generally reach their highest elevation near the middle, and towards their extremities droop gradually down into the plain. The lateral ridges which break off from these may again, in their turn, send off minor ridges or spurs in numerous ramifications.

Mountain chains have, in general, very steep declivities on one side, and very gradual slopes on the other; the latter is called the **slope**, the former the **counter-slope**. The Alps, for example, descend abruptly towards Italy, but gently towards Switzerland; and the Pyrenees are steep to the south, but sloping towards the north; while the Asturias or Cantabrian Mountains are the reverse. The same law applies, as we have seen, to the land-masses of the great continents.

These chains frequently traverse immense regions, forming the barriers of great nations dwelling around their base. The Andes, for example, continued by the Mexican and Rocky Mountains, extend through all the different zones and climates of the world.

10. Height of Mountains.—To the eye of the spectator, the most striking feature of mountains is their height; and it might be readily inferred that such elevations would destroy the perfectly spherical form of the earth, and render it an irregular body. But although the highest mountain of the globe is 29,002 feet, or very nearly $5\frac{1}{2}$ miles in height, it is only $\frac{1}{1440}$ of the earth's diameter; that is to say, it would be correctly represented

by a grain of sand, $^1/_{80}$ of an inch in thickness, laid upon the surface of an artificial globe 18 inches in diameter. Yet the imagination cannot fail to be impressed with the mass and majesty of Titanic forms rising miles into the air, and with the mysterious solitudes of summits unapproachable to human footsteps.

The Himalayas exhibit the greatest elevations as well as the greatest mass of any mountain system of the globe; they send up no less than twenty-two summits above 20,000 feet, six of which are above 25,000. Their mean height, according to Humboldt, is 15,670 feet. Whilst the Andes exceed them in length, they are of inferior elevation, and only fourteen summits have an altitude of more than 20,000 feet. Yet the mean elevation of the Andes is 11,830 feet, and their bases occupy an area of nearly one-sixth part of the continent of South America.

DIMENSIONS OF PRINCIPAL MOUNTAIN CHAINS.

CHAIN.	LENGTH.	BREADTH.	MEAN HEIGHT.
Alps,	600 Miles.	80 to 200 M.	7700 Feet.
Pyrenees,	300 ,,	60 ,,	8000 ,,
Apennines,	800 ,,	.....	4000 ,,
Carpathians,	800 ,,	.....	5000 ,,
Balkan, or Hæmus,	600 ,,	.....	4900 ,,
Urals,	1600 ,,	16 to 66 ,,	2000 ,,
Scandinavian Mountains,	1150 ,,	60 to 200 ,,	4500 ,,
Himalayas,	1500 ,,	100 to 160 ,,	15670 ,,
Caucasus,	750 ,,	65 to 150 ,,	8500 ,,
Atlas,	1600 ,,	50 to 90 ,,	7000 ,,
Rocky Mountains,*	5000 ,,	570 to 1040 ,,	5000 ,, ?
Appalachians, or Alleghanies,	2000 ,,	150 to 200 ,,	2500 ,,
Andes, or Cordilleras,	4500 ,,	40 to 400 ,,	11830 ,,

11. **Hills.**—In popular language the term *hill* is applied to inferior elevations, and *mountains* to higher ones; but there is a wider distinction between them, which is geological and structural rather than geographical in character. Mountains consist generally of continuous

* Including the whole Pacific System; Rocky Mountains proper, 3000 miles long.

groups or chains, while hills are more usually isolated or detached. Mountains are formed of the older and harder rocks which have been upheaved through the stratified and softer materials, and these broken and soft rocks have been worn away, at least in great part, by aqueous action. Hills, on the other hand, are composed more generally of the soft stratified rocks of the surrounding country, smoothed and rounded by the action of the weather, more particularly of frost and rain. The former have been subject to aqueous denudation, the latter to aërial denudation. To the latter process are due the irregularities that occur in the surface of table-lands. Viewed in the light of these observations, the Malvern Hills (1396 feet high) in the south-west of England, are really mountains, and not hills, for they are composed of syenite.

12. **Uses of Mountains.**—Mountains are not mere objects of interest from their sublimity or beauty; they play an important part in the economy of nature. Their summits arrest and condense the moisture of the atmosphere into dews, snows, and rains; and from bubbling spring or melting glacier, they again send them forth along their slopes by brooks and rivers, to refresh and fertilize the plains below. Whilst in all countries influentially affecting climate, they temper, by their cooling breezes, the heat of Torrid climes. They are the great treasuries of our mineral wealth—even the golden sands of rivers having been worn and washed out of their veins. They increase the surface of the earth; they diversify its productions; and they give richness and variety to the landscape. While their snow-clad summits have formed barriers, even more impassable than the ocean, to the dispersion of plants and animals, and to the spread of the languages and races of mankind, they have nursed within their bosoms generations of hardy and patriotic men, who have made their mountain-fastnesses the impregnable strongholds of freedom.

PRINCIPAL MOUNTAINS OF THE GLOBE.

Systems.	Chief Ranges.	Position.	Direction of Range.	Highest Summits.
EUROPE.				
Hesperian, or Spanish,	Pyrenees, & Cantabrian Mts.,	N. of Spain,	E. to W.	Mount Maladetta, 11,168 ft.
	Sierra Nevada, &c.,	S. of Spain,	E. to W.	Cerro Mulhacen, 11,678 ft.
	Alps proper,	Switzerland and N. of Italy,	E. to W.	Mont Blanc, 15,744 ft.
Alpine,	Mountains of France,	E. and S.E. of France,	N. to S.	Mt. Molleson (Jura Mts.), 6,588 ft.
	Apennines,	Italy and Sicily,	N.W. to S.E.	Mount Etna, 10,874 ft.
	Slavo-Hellenic Mts., viz.:			
	Dinaric Alps and Pindus,	Turkey and Greece,	N. to S.	Olympus, 9,749 ft.
	Balkan Mountains, &c.,	Turkey,	E. to W.	Tchar-Dagh, 9,700 ft.
	Carpathian Mountains,	E. of Austria,	(Semicircular),	Mount Botschetje, 9,528 ft.
	Germanic Mountains,	S. of Germany, &c.,	E. to W., N. to S.	Schneekoppe (Riesen Gebirge Mts.), 5,255 ft.
Uralian,	Ural Mountains,	Bet. European and Asiatic Russia,	N. to S.	Konjak-Ofski, 5,397 ft.
Scandinavian,	Kiolen, Dovrefield, & Langefield Mountains,	Norway and Sweden,	N.E. to S.W.	Skageslöestinden, 8,070 ft.
British,	Grampians, &c.,	British and Faröe Isles,	N.E. to S.W.	Ben Nevis, 4,466 ft.
ASIA.				
Western,	Armenian Mountains,	Bet. Turkey and Persia,	E. to W.	Mount Ararat, 17,112 ft.
	Caucasus Mountains,	Bet. Caspian and Black Seas,	E. to W.	Mount Elburz,* 18,493 ft.
	Taurus and Anti-Taurus,	Asia Minor,	E. to W.	Arjish-Dagh, 13,197 ft.
	Lebanon Range,	Syria, & Peninsula of Sinai,	N. to S.	Mount Hermon, 10,000 ft.
	Zagros, or Kurdistan Mts.,	West of Persia,	N.W. to S.E.	Mount Bistun, 12,000 ft.
	Elburz Mountains,	North of Persia,	E. to W.	Mount Demavend, 21,000 ft.
	Hindoo Koosh Mountains,	Bet. India and Turkestan,	E. to W.	Hindoo Koosh, 20,000 ft.
	Suliman Mountains,	Afghanistan & Beloochistan,	N.E. to S.W.	Takht-i-Suleimaun, 6,260 ft.

* This summit is situated in Europe, and therefore the highest point of that continent, but the whole range is strictly Asiatic.

PRINCIPAL MOUNTAINS OF THE GLOBE—*continued.*

Systems.	Chief Ranges.	Position.	Direction of Range.	Highest Summits.
ASIA—continued.				
Central,	Bolor Tagh,	Bet. Chinese and Independent Turkestan,	N. to S.	? . 19,000 ft.
	Altaï Mountains,	N. of Chinese Turkestan,	W. to E.	Bielukha, . . . 12,796 ft.
	Thian-Shan Mountains,	Chinese Turkestan,	W. to E.	Khan Tengri, . 21,000 ft.
	Kuen-Lun,	Bet. Chinese Turkestan and Tibet,	W. to E.	? . 22,000 ft.
	Karakorum Mountains,	Bet. Chinese Tartary and Little Tibet,	N.W. to S.E.	Dapsang Peak, . 28,278 ft.
	Himalaya Mountains,	Bet. Tibet and India,	N.W. to S.E.	Mount Everest, 29,002 ft.
North-Eastern,	Khin-gan, In-shan, and Yun-ling Mountains,	E. of Mongolia and Tibet,	N. to S.	?
Eastern,	Yablonoi and Aldan Mts,	S E. of Siberia,	W. to E.	?
	Pe-ling and Nan-ling Mts.,	N. & S. of China Proper,	W. to E.	12,000 and 8,000 ft.
South-Eastern,	Mountains of Arracan, Burmah, Siam, and Annam,	Further India,	N. to S.	Tidi-bang-sa, . 6,561 ft. (Malaya).
Indian,	Neilgherries, E. & W. Ghauts, Vindhya Mountains, &c.,	Southern India,	N. to S. / E. to W.	Dodabetta, . . 8,760 ft. (Neilgherries).
AFRICA.				
Northern,	Atlas Mountains,	Barbary,	E. to W.	Mount Miltsin, . 11,400 ft.
	. . . . .	Canary Islands,	. . . . .	Peak of Teneriffe, 12,182 ft.
Western,	Kong Mountains,	N. of Upper Guinea,	E. to W.	Mount Rennel, . 3,200 ft.
	Cameroon Mountains,	Biafra, in Upper Guinea,	N. to S.	Pico Grande, . 13,129 ft.
Southern,	Nieuveldt and Sneeubergen Mountains,	Cape Colony,	E. to W.	Compassberg, . 9,000 ft.
Eastern,	Drakenberg, Lupata Mts., &c.,	Natal, Mozambique, Zanguebar,	N. to S.	Kilimandjaro, . 20,000 ft.
	Abyssinian Mountains,	Abyssinia,	. . . . .	Ras Detschen, . 15,986 ft.
	Madagascar Mountains,	Madagascar,	N. to S.	Ankaratra, 10,000 to 12,000 ft.

Systems.	Chief Ranges.	Position.	Direction of Range.	Highest Summits.
	AFRICA—continued.			
Central,	Mountains of the Moon,	Equatorial Africa,	E. to W. ?	? 10,000 ft.
	Chadda Mountains,	South of Lake Tchad,	E. to W. ?	Mount Alantika, 10,000 ft.
	NORTH AMERICA.			
Eastern, or Atlantic,	Appalachian or Alleghany Chain,	United States and Canada,	N.E. to S.W.	Mount Washington, 6,428 ft.
Western, or Pacific,	Rocky Mountains Chain,	Arctic O. to Isth. of Panama,	N. to S.	Vol. Popocatepetl, 17,783 ft.
	Pacific, or Oceanic Mt. Chain,	W. Coast of North America,	N. to S.	Vol. Mt. St. Elias, 14,970 ft.
	SOUTH AMERICA.			
Western,	The Andes,	Isth. of Panama to C. Horn,	N. to S.	Aconcagua, 23,910 ft.
Eastern,	Brazilian Mountains,	East of Brazil,	N. to S.	Itambé (Sierra Espinhaço), 5,960 ft.
	Parimé and Guiana Mts.,	S. of Venezuela and Guiana,	E. to W.	Maravaca, 10,500 ft.
	OCEANIA.			
Australasian,	Australian Alps, &c.,	E. of Australia & Tasmania,	N. to S.	Mount Hotham, 7,500 ft.
	Southern Alps,	South Island, New Zealand,	N. to S.	Mount Cook, 12,460 ft.
Malaysian,	Mountain Chains of Sunda Isles,	Sumatra, Java, &c.,	N.W. to S.E.	Mt. Kassoumba, 15,000 ft.
	Mountains of Borneo,	Borneo,	S.W. to N.E.	Mount Kini Balu, 13,700 ft.
Polynesian,		Sandwich Islands,		Vol. Mouna Kea, 13,950 ft. Vol. Mouna Loa, 13,760 ft.

TABLE-LANDS OR PLATEAUX.

13. The greatest mass of elevated land does not consist of mountains, but is spread out in extensive upland plains, called **plateaux** or **table-lands.** These plateaux are not necessarily flat, but consist of considerable areas of plain surface high above sea-level, and may be varied by hill and dale, lake and river. They are frequently supported round their margins by mountain ridges, whose abrupt descent to the plains below imparts that table-like form whence they have derived the name of *table*-lands. They may also descend to the lowlands by gradual slopes, or successive terraces. Table-lands are intimately associated with mountains, and frequently serve as platforms from which new ridges rise. Indeed, the highest mountains of the globe rise from such regions, and many of the noblest rivers gather thence their far-fetched waters.

EUROPE. — Compared with the other continents, Europe has no table-lands of great extent or elevation. Its most remarkable one is that of **Spain,** which occupies an area of 93,000 square miles, or more than half the peninsula, and has a mean elevation of 2200 feet. There are also the plateaux of **Switzerland,** with **Bavaria** and **Bohemia,** of much inferior elevation.

ASIA.—The table-lands of Asia occupy $^2/_5$ of the entire continent. That gigantic mass of high land, which forms the girdle of the Old World, extends through Asia a distance of 6000 miles, and is 2000 miles broad at its eastern extremity, 700 to 1000 in the middle, and somewhat narrower towards the Mediterranean. It largely expands into broad and lofty table-lands, traversed and supported by colossal mountains. These table-lands consist of two great divisions,—viz., (1) The Eastern Plateau, or Central Asia; and (2) the Western Plateau, united to the Eastern by the great mountain-isthmus of the Hindoo Koosh.

Central Asia, or **High Asia,** is the most extensive and elevated table-land on the globe. Its marginal walls are

the Himalayas, the Bolor Tagh, the Altaï Mountains, and the Chinese Mountains, whilst it is traversed by the great Ku-en-lun and Thian-shan ranges. In this area is included the great rainless sandy Desert of **Gobi** ("naked desert"), or **Shamo** ("sea of sand"), with an elevation of 3000 feet, and an area of 400,000 square miles, or twice the size of France. In the centre is a district called **Han-Hai** ("dry sea"), 150 miles in length by 20 in breadth, consisting entirely of loose shifting sands, and altogether impassable. In the south is the plateau of **Tibet**, the loftiest inhabited land in the world, with an elevation of 15,000 feet, equal to the highest summits of the Alps, and rising in some parts to 17,000 feet. A portion of this vast tract (the table-land of **Pamir**), near the source of the River Oxus, called in the native language Bam-i-Duniah, the "Roof of the World," forms the highest watershed on the globe, and is the great centre from which radiate all the great mountain chains and largest rivers of Asia.

South-west from Central Asia extend in succession the great table-lands of **Iran**, or Persia, **Arabia**, and the **Sahara**, or **Great Desert**, in Africa. These, along with the table-lands of Central Asia, belong to the same vast belt of arid, sandy rainless country, destitute of streams and vegetation, which extends over more than 120° of longitude and 17° of latitude, or about 5,000,000 square miles. Apart from these are the plateaux of **Armenia** in Western Asia, and the **Deccan** in the Indian Peninsula.

AFRICA.—Africa presents so great a mass of elevated land that it has been compared to an inverted pudding-dish. Under the Equator itself the country is so elevated as to enjoy all the advantages of a temperate climate. All the southern half strongly resembles the Deccan with its triangular elevated platform flanked by long mountain ranges, and descends to the south in a succession of terrace-plains, called **Karroos**.

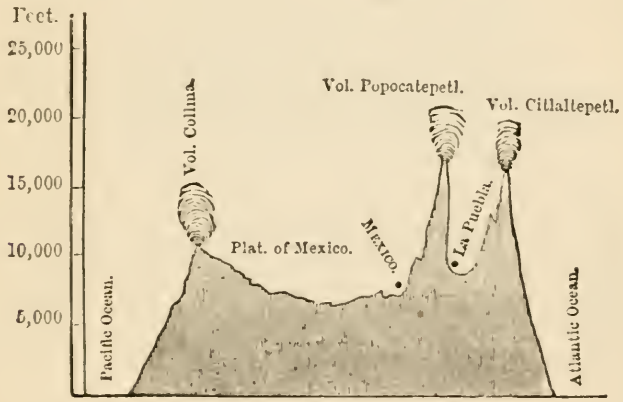
The **Sahara**, or **Great Desert**, in the north of Africa,

is partly lowland and partly upland: in some portions it is low and flat, especially in the west; in others, it is said to sink below sea-level; but it consists for the most part of bare broad plateaux of 1000 to 3000 feet in height. It is the most extensive sterile tract of the globe, having an area equal to that of the Mediterranean. It presents a vast expanse of burning sands, rocks, or loose shingle, with here and there brackish lakes or springs, and the ground incrusted with salt, whose particles flash in the sun like diamonds. Without stream, rain, or dew, it possesses no vestige of animal or vegetable life, save where, at distant intervals, some low-lying spring gives birth to a patch or islet of vegetation, called an **oasis.** Such favoured spots may be descried afar over the arid waste by their clumps of date-palms, ferns, and acacias, and they afford a welcome resting-place to the fainting caravan. Like the mariner at sea, the traveller guides his course by the compass, or the stars, across this "ocean without water," not in a direct line, but to the nearest *oasis.* Without the fountains of the oasis, indeed, to recruit his exhausted skin-bottles, and without the camel, "the ship of the desert," to transport him, this vast region would be quite impenetrable to man. But not unfrequently the party of the caravan fall victims to the deadly blast of the simoom, or sink, baffled and bewildered, beneath the drifting sands.

"On the interminable sands and rocks of these deserts no animal—no insect—breaks the dead silence; not a tree nor a shrub is to be seen in this land without a shadow. In the glare of noon the air quivers with the heat reflected from the red sand, and in the night it is chilled under a clear sky sparkling with its host of stars. Strangely but beautifully contrasted with these scorched solitudes is the narrow valley of the Nile, threading the desert for 1000 miles in emerald green, with its blue waters foaming with rapids among wild rocks, or quietly spreading in a calm stream, amidst fields of corn and the august monuments of past ages."—*Mrs. Somerville's Physical Geography.*

NORTH AMERICA.—The **Table-Land of Mexico,** though not the highest, is by far the most unbroken on

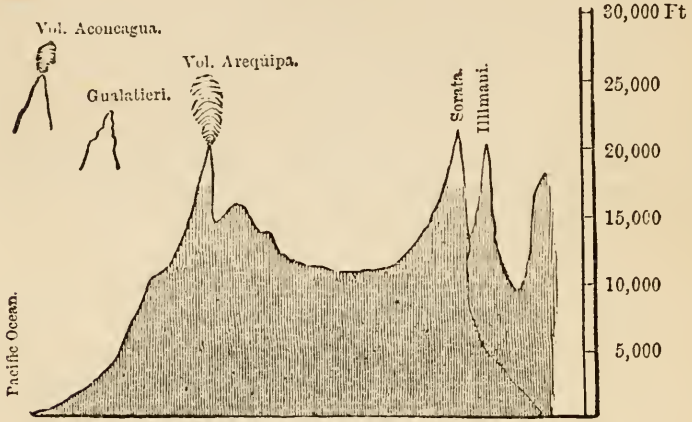
the face of the earth. It is 1600 miles in length from north to south, being a distance as great as from the north of Scotland to Gibraltar, with a width of 360 in the latitude of the capital. The country rises abruptly from both shores, but less so from the Pacific, and its whole mass is raised into the air to a medium height of 7000 feet. It seems like a flattening and broadening of the great meridional chains of the Americas. Its surface is almost as level as the ocean, save where volcanic cones shoot up from its expanse. The city of Mexico stands in the midst of a grand volcanic circuit of mountains with snowy flanks and blazing crests.



SECTION OF THE PLATEAU OF MEXICO.

SOUTH AMERICA.—The **Plateau of Bolivia, or Upper Peru,** situated between the two Cordilleras, or main chains of the Andes, at an altitude of 12,900 feet (about 2½ miles), has an area of 150,000 square miles, or three times the size of England. It is bounded by the highest summits of the Andes, rising to nearly double its own height; its Lake of Titicaca is twenty times the size of the Lake of Geneva; its valleys are rich and fertile; villages are situated, and mines of silver worked, at heights as great as the Peak of Teneriffe or Mont Blanc;

it also possesses great and populous cities, and many traces of the power and civilisation of its ancient inhabitants. The **Plateau of Quito**, 200 miles long and 30 wide, and immediately under the Equator, is 9600 feet



SECTION OF THE PLATEAU OF BOLIVIA.

(or nearly 2 miles) above the level of the sea. The city of Quito itself, with its 70,000 inhabitants, enjoys the magnificent spectacle of eleven *nevadoes*, or snow-clad mountains, rising from amid verdant hills around the city, some of them not unfrequently tipped with smoke and flame.

PRINCIPAL PLATEAUX.

PLATEAU.	POSITION.	AREA.	MEAN HEIGHT.
	EUROPE.		
Spanish Plateau,	Central Spain,	93,000 sq.m	2,000 to 3,000 ft.
Plateau of Switzerland,	Between Lake of Geneva & Lake Constance,	6,000 ,,	1,350 to 2,000 ,,
Bavaria,	South of Germany,	30,000 ,,	1,500 to 2,000 ,,
Bohemia,	N.W. of Austria,	20,000 ,,	900 to 1,500 ,,

PRINCIPAL PLATEAUX—*continued.*

PLATEAU.	POSITION.	AREA.	MEAN HEIGHT.
	ASIA.		
Eastern Plateau, comprising—	Central Asia,	7,600,000sq.m.	15,000 to 17,000 ft.
Gobi, or Shamo,	,,	400,000 ,,	4,000 to 6,000 ,,
Tibet,	,,	166,000 ,,	10,000 to 15,000 ,,
Valley of Cashmere,	N.W. of India,	25,000 ,,	5,500 to 6,000 ,,
Western Plateau, comprising—		1,700,000 ,,	4,000 to 7,000 ,,
Iran,	Persia & Afghanistan,	300,000 ,,	3,000 to 6,000 ,,
Armenia,	S.E. of Black Sea,	70,000 ,,	7,000 ,,
Anatolia,	Asia Minor,	200,000 ,,	3,000 ,,
Arabian Plateau,	Central Arabia,	700,000 ,,	3,000 to 6,000 ,,
The Deccan,	Southern India,	250,000 ,, ?	1,400 to 3,000 ,,
	AFRICA.		
Sahara, or Great Desert,	Northern Africa,	3000×1000 m.	1,000 to 3,000 ,,
Plateau of Amhara,	Abyssinia,	?	6,000 to 8,000 ,,
South Central Africa,	from 5° N. Lat., Southwards,	?	3,000 ,,?
Kalahari Desert,	N. of Cape Colony,	236,000 sq.m.	2,000 to 3,000 ,,
Great Karroo,	N. of Nieuveldt Mountains,	200×50 m.	2,000 ,,
	NORTH AMERICA.		
Labrador,	E. of Brit. America,	420,000 sq.m.	2,000 ,,
Great Western Plateau,	From Rocky Mts. to Pacific Range,	?	5,000 ,,
Anahuac,	Central Mexico,	1,600×360 m.	7,000 ,,
Guatimala,	Central America,	?	2,000 to 5,000 ,,
	SOUTH AMERICA.		
Plateau of Quito,	Andes of Ecuador,	6,000 sq.m.	9,600 ,,
Plateau of Bolivia,	Andes of Bolivia,	150,000 ,,	12,900 ,,
Plateau of Brazil,	Interior of Brazil,	1,500,000 ,,	3,000 ,,

LOWLAND PLAINS.

14. OLD WORLD.—That great zone of high land which extends from the Atlantic to the Pacific, divides the Old World into two very different regions. That to the south of it is, with isolated exceptions, high and mountainous; that to the north forms the **Great Northern Plain**, which stretches from the German Ocean eastwards to Behring's

Straits, interrupted, and that only partially, by the transverse range of the Urals. "The traveller may cross the Ancient World for a distance of more than 6000 miles without encountering an eminence of more than a few hundred feet in height." It extends over 190° of longitude, and includes an area of nearly 6 millions of square miles, $^1/_2$ larger than Europe, or nearly $^1/_3$ of both Europe and Asia. The European section of this vast expanse is divided into the **Germanic Plain** in the west, and the **Sarmatian Plain** in the east; while in Asia it is occupied by the **Steppes of Kirghiz, Ischim,** and **Baraba,** in the south-west, and the **Siberian Plain** in the north.

Great Plain of Europe.—From the Carpathians to the Urals, a distance of 1500 miles, there is almost a dead level. In the west of Russia, rivers that flow north and south to the Baltic and Black Seas take their rise under the shadow of the same tree; when in flood, they convert the swamps around their source into one continuous lake, so that the traveller might pass by boat, without interruption, from the Baltic to the Euxine. One river, the Pripet, creeps along to the Dnieper through a swamp as long as England. On the west, the polders and morasses of Holland are preserved from the overflow of the sea by means of dykes; and in the south-east, on the shores of the Caspian, the land dips 83 feet below the ocean level. A strong wind from the north drives the waves of the Baltic into the mouth of the Oder, and gives its waters a backward course for 30 or 40 miles. In the Germanic section occur the mud flats of Holland, the boulder-strewn sandy plains of Prussia, and the pastures, heaths, and swamps of Denmark and the northern sea-board. In the Sarmatian Plain, the cold swampy flats of the north, and the natural forests of pine and fir, with the great fertile grain-bearing tracts of the middle, are succeeded, in the south, by the steppes.

Steppes.—These steppes, as their name implies, are

"deserts without trees," covered in the west with long coarse grass and gravel, and in the east with saline deposits as white as hoar-frost. The steppes of Asia present a monotonous dead level bounded by the horizon. Upon their rough grass and shrubs countless horses, camels, and cattle browse during a brief season of verdure; but summer droughts convert them into parched deserts, and winter snows into scenes of trackless desolation. The steppes alone are estimated to cover a surface of 1,000,000 square miles.

Tundras.—Along the north of Russia and Siberia are low-lying **tundras**, or earthy peat mosses, where the ground is perpetually frozen to a great depth, except for a few weeks in summer, when the surface is partially thawed.

Landes ("heaths") are extensive tracts on the coast of the Bay of Biscay, between the Gironde and the Pyrenees, generally sandy, sometimes marshy, mostly covered with heath and dwarf shrubs. Over these grounds the natives generally walk on stilts.

Dunes are low sand-hills which stretch along the coast of the Netherlands and north of France. They are formed of drifted sands, and effectually protect the low-lying country from the overflow of the tides. They are partially covered with grass and heath, and are unfit for pasturage or cultivation.

Polders are flat tracts in Holland below the level of the sea or nearest river, such as a lake or morass which has been drained and brought under cultivation. They are protected from inundation by embankments called *dykes*. Similar to these are the Fens of England.

Secondary Plains.—Of the secondary plains of the Old World, the most important are those of the **Middle** and **Lower Danube**; the fertile **Valley of the Po**, in Northern Italy; the great river **Plain of China**, equal in area to the whole of France; the **Plains of Hindostan**, stretching from the Himalayas to the Deccan along the north of India; and the historic **Plains of Mesopotamia**

(between the Euphrates and the Tigris), in Western Asia, the seat of the earliest empires. The greater part of the interior of Australia was long believed to be "a treeless uninhabited desert of sand and shingle, probably the bed of a dried-up sea, and all but impassable from the want of water;" but recent explorations have materially modified this opinion. "A large part of the surface is occupied by extensive sandy and stony deserts; elsewhere, fine pasture and woodland are met with; while, in many places, the country is well-watered, with undulating hills."

15. New World—But great plains are the most characteristic feature of the New World. A great **Central Plain** may be said to extend from the Arctic Ocean to Tierra del Fuego, although broken by the Gulf of Mexico and the Caribbean Sea. Whilst its extremities, more than 9000 miles apart, are charged with the Arctic and Antarctic snows, its middle is overshadowed by tropical palms. In North America it is contained on the west and east by the Rocky Mountains and the Alleghanies, and in the southern continent by the Andes and the Cordilleras of Brazil.

Prairies.—In North America, rising ground of no great elevation along the 50th parallel, turns the water to the north towards the Arctic Ocean, and to the south by the great basin of the Mississippi. This latter great tract, comprising an area of 3,000,000 square miles, has been characterized by Humboldt as "an almost continuous region of savannahs and prairies." The prairies on both sides of the Mississippi, but chiefly on the west, are vast natural "meadows,"—most of them level or of a rolling or undulating surface, without trees or water, and covered with luxuriant grass and flowers. On the wide plains roam countless herds of wild horses, bisons, and deer. At the base of the Rocky Mountains, and near the sources of the Missouri, is the **American Desert**, a vast tract of sand and gravel; but eastwards towards the Alleghany Mountains the plain is covered with

immense natural forests, many of them still untouched by the woodman's axe. Along the Gulf of Mexico, and far into the interior, are the **Pine-barrens**, extensive monotonous tracts of sand, clothed with gigantic pine-trees.

In South America the Central Plain is divided into three distinctive and well-marked river plains, viz., those of the Orinoco, the Amazon, and the La Plata.

(1) **Llanos.**—The first is the region of the **Llanos**, or grassy flats, extending over 160,000 square miles. Over hundreds of miles the surface-level often does not vary a single foot, and in the wet season it is overflowed for hundreds of square miles. Shortly after, they become so richly clothed with verdure as to be called in the native language, "the sea of grass;" but in the succeeding drought the grass crumbles into dust, and the luxuriant tropical vegetation, parched and withered, is often consumed like tinder in one wide wasting conflagration.

(2) **Selvas.**—The second, or plain of the Amazon, is the largest river basin in the world, being 1,500,000 square miles in area ($^3/_4$ of European Russia, or seven times the size of France). It is distinguished by its **Selvas** ("forests") covered with the rankest forest-growths, so dense that they can be threaded only by the river-courses. At the annual inundation the natives take to the trees, and form villages among the interlacing branches. "Were it not for intervening rivers, the monkeys, almost the only inhabitants, might pass along the tops of the trees for several hundreds of miles without touching the ground."

(3) **Pampas.**—The third division is the **Pampas** ("plains") of the La Plata and is 880,000 square miles in extent. It consists chiefly of rich alluvial soil, destitute of trees, with grassy pastures and immense flats, covered at one season with gigantic thistles, some of them ten feet high; at another, with the richest clover. Troops of wild horses and cattle scour the plains, or browse, almost concealed,

among the luxuriant thistles and other herbage. Bounded on the east by the River Paraguay is the immense arid sandy desert of **El Gran Chaco**; along the west, near the base of the Andes, is a great salt desert bearing the name of **Las Salinas**; and a desert of shingle, 700 miles in length, consisting of five great terraces sloping eastwards, extends through eastern Patagonia.

16. **Uses of Plains.**—Whilst mountains and plateaux play a most important part in the physical economy of nature, the plains, from their milder climate, fertile soil, and well-watered surface, have been the chief nurseries of animal and vegetable life, the chief seats of population, and the great theatres of industry and civilization. In spite of immense wastes of barren sands, salt, and shingle that cumber so much of the earth,* they have formed from the earliest ages the pasture-lands of roving tribes; or the busy plough of the husbandman has made them the rich granaries of the globe.

PRINCIPAL PLAINS.

PLAIN.	POSITION.	AREA.
	EUROPE.	
The Great Plain,	in the Centre and East of Europe,	2,500,000 sq. m.
Plain of Middle Danube,	in Hungary,	25,000 ,,
Plain of Lower Danube,	in North-East of Turkey,	66,000 ,,
Plain of Lombardy, or Valley of the Po,	in the North of Italy,	40,000 ,,
Plain of France,	in the North-West and West of France,	
	ASIA.	
The Great Northern Plain,	Siberia,	5,000,000 ,,
Plain of Turkestan,	East of the Caspian,	1,000,000 ,,
Plain of Mesopotamia,	S.E. of Turkey in Asia,	165,000 ,,
Plains of Hindostan,	in the North of India,	
Plain of China,	Middle of China Proper,	210,000 ,,
Plains of Indo-China,	Farther India,	?

* Deserts are estimated to occupy five or six millions of square miles, *i.e.*, about one-half larger than Europe, or 40 to 50 times the size of the British Isles.

PRINCIPAL PLAINS—*continued.*

PLAIN.	POSITION.	AREA.
	AFRICA.	
Great Central Plain, ...	South of Sahara, ...	?
	NORTH AMERICA.	
Great Central Plain, ...	from Arctic Ocean to Gulf of Mexico, ...	3,000,000 sq. m.
The Atlantic Plain, ...	between the Appalachians and Atlantic, ...	767,000 ,,
	SOUTH AMERICA.	
Great Central Plain, ...	from the Caribbean Sea to the Rio de la Plata, ...	
comprising,		
The *Llanos* of the Orinoco,	in the North, ...	160,000 ,,
The *Selvas* of the Amazon,	in the Middle, ...	1,500,000 ,,
The *Pampas* of La Plata,	in the South, ...	880,000 ,,
Desert of Patagonia, ...	in the East of Patagonia, ...	140,000 ,,

17. Valleys.—Valleys are great natural depressions on the earth's surface, generally occupied by streams, from which they receive their names. They are of different characters, according as they occur in the upper or the lower course of rivers, or on the wide expanse of table-lands.

(1) In the first case they are closely associated with mountains, being bounded by their precipitous sides, high above sea-level, and they contain the mountain torrent which receives the product of the springs, rains, or snows of the adjoining heights. The scenery is generally grand and picturesque. The stream is intercepted by natural obstacles so as to form lakes, or foams in cascades and waterfalls over the rugged and precipitous bottom. Many of them are valleys of erosion, owing their existence to the ceaseless action of running water, wearing and undermining the rocks, carrying the *debris* farther down the valley, and thus ever deepening their channels as they flow. Others are valleys of fracture or fault, formed originally when the mountain-masses were upheaved, when the rocks were cracked and broken, and the two

sides of the fissure deposited apart, and perhaps at different levels. The clefts or crevices thus caused became afterwards the beds of running streams gathered from the mountain sides. These valleys may be either longitudinal or transverse, according as they run parallel with the length of the main mountain chain, or cut it at right angles. By means of the transverse valleys, often of great depth, as in the Alps and Himalayas, access is afforded to those mountain-passes which form the connecting links between countries on opposite sides of great mountain-barriers.

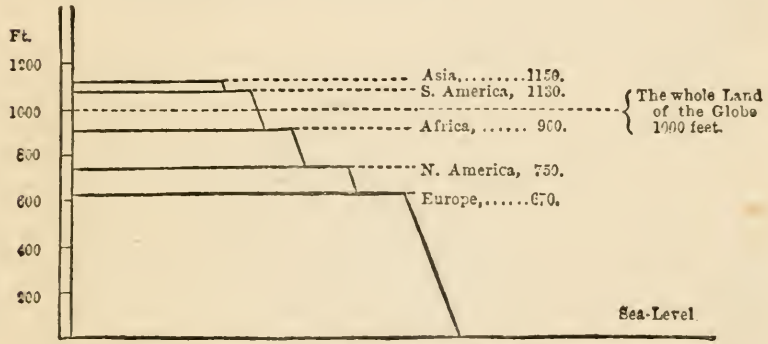
(2) The second case occurs in the lower river-course, where the narrow glen or ravine widens out into open plain, generally before the river approaches the sea, when its confines are ill-defined, and it differs little except in name from the broad open plain of the country around. Such are the valleys of the Ganges, the Mississippi, the Amazon, and other large rivers. The other belongs to almost all streams of mountain origin.

(3) The valleys of table-lands are generally deep clefts or gorges, cutting abruptly the mountains or plateaux they traverse. Their sides are precipitous, although often miles apart, the scenery is often very grand and striking, and they interfere materially with communication between the opposite banks. Such are the river-valleys of Spain, the course of the Zambesi in South Central Africa, the Cañons of the Rio Colorado in North America, and the plains of Western Tibet.

MEAN ELEVATION OF THE CONTINENTS.

Thus, on a general review of the land-surface, we may observe that in the Old World *mountains and plateaux predominate* — $^5/_7$ of Asia and $^1/_4$ of Europe being thus occupied. The New World, on the other hand, is the *world of plains*, which form $^2/_3$ of its surface. All the mountains, and more especially the table-lands, tend to raise the general level, while the plains have the import-

ant effect of largely reducing it. If the whole mass of the Pyrenees were reduced to powder and strewn equally over the surface of Europe, it would raise the general level by 6 feet; the Alps would raise it 22 feet; whilst the plateau of Spain, if treated in a similar manner, would heighten the surface 76 feet. If all the mountains and table-lands of the globe were to be thus broken up and spread out over their respective continents, it has been calculated that the mean elevation of the continents would be as follows:—Europe, 670 feet; Asia, 1150 feet; Africa, 900 feet; North America, 750 feet; and South America, 1130 feet; the whole land of the globe, nearly 1000 feet.



COMPARATIVE VIEW OF THE MEAN ELEVATION OF THE CONTINENTS.

EXERCISES.

1. Which continent appears to present an exception to the first law of vertical arrangement? Let the pupil draw a section of Europe from the Baltic to the Plain of Northern Italy. Point out and name the chief mountain chains in both the Old and the New World that do not follow the direction of the continents. Measure the great mountain axis of the Old World and the New. Where is it most remote from the ocean, and how far? Where is this axis most interrupted, and where is it broken by the sea? Which African chain belongs to it, and how is it detached from it? Which is the central mountain system of Europe? Which are entirely unconnected with it? Give the chains that occupy the leading peninsulas and islands of the

world. Give the islands which may be considered as prolongations of the Maritime or Western Alps, the Apennines, Mount Atlas, the Urals, the Scandinavian Mountains. Which important mountain chain is nearly half-way from the Equator to the Pole? Which European peninsula is not mountainous, and how does it differ from the others?

2. What is the central chain of Western Asia? What chains radiate from it, and in what directions? What is the chain of Central Asia from which all the others may be said to radiate? Which chain is half-way along the great mountain axis of the Old World? Which chain connects the Western and the Central system of Asia? Arrange in tabular form the culminating points of the six great land divisions of the globe with their respective mountain ranges. Give a comparative view of their heights, by a scale or otherwise. Reduce the heights to miles, and compare them with that of some height with which you are familiar. Lay down on a map the leading mountain ranges in the world and their culminating points.

3. Which of the continents may be considered as forming one great plateau? Which contains the highest and largest plateaux? Which the fewest? Name the several plateaux connected with the Himalayas, the Alps, the Rocky Mountains, the Andes. Name those in peninsulas, and state how these peninsulas resemble each other in respect of outline. What mountain chains support the table-lands of Iran? of Armenia? of Anatolia? the Deccan? Spain? South Central Africa? Which plateaux are traversed by mountains? Point out the greatest series of table-lands on the globe. How are they separated from each other? In what respect do they resemble each other? Write out, from memory, a descriptive account of the Desert of Sahara. Arrange the principal table-lands in the order of their heights. Compare their mean elevations with each other, and with some well-known height. Compare their areas with that of the British Isles.

4. How are the lowlands of Asia situated relatively to the whole continent? How do those of the New World differ from them in relative position? How do the great lowlands and plateaux of the Old World lie respectively from the great mountain axis? Name the countries embraced in the Great Northern Plain of the Old World and in the Great Central Plain of the New World. What feature in common have the secondary plains of the Old World? What rivers traverse these plains? What mountains bound them? Which European plains form prolonged portions of the Great Plain? Which Asiatic plains have corresponding relative positions to the Plains of Lombardy and the Lower Danube? Write out from memory a descriptive account of the Great Northern Plain, and of the Great Central Plain. Compare the areas of the principal plains with that of the British Isles.

CHAPTER III.

THE WATERS OF THE OCEAN.

Divisions—Dimensions of the Oceans—Configuration—Mutual Relations of Land and Water—Depth—Quantity—Temperature—Saltness—Colour—Waves—Tides—Tide-Waves—Currents—Causes of Currents—Equatorial Current—The Gulf Stream—The Arctic Current—Uses of Currents—Table of Ocean Currents.

18. Divisions.—Although the waters which engirdle the earth and fill up its vast abysses, form but one continuous expanse, having no detached portions like the land, they have been, for convenience' sake, divided into Five Great Basins, called **Oceans.** This division, as well as their configuration, is dependent upon the arrangement and forms of the great land-masses. Two, the **Pacific** * and the **Atlantic,** † extend between the great Eastern and Western Continents; two, the **Arctic** and **Antarctic** (or Northern and Southern), are *polar;* while the **Indian Ocean,** cut off from the Pacific by Australasia, may be styled *equatorial.* A certain correspondence in the relative positions, forms, and areas of the land and water of the globe may be observed by comparing—

(1) The Pacific and the Old World;
(2) The Atlantic and the New World.
(3) The Indian Ocean and Australia.

As the Old World is about twice the size of the New, so the Pacific is twice the size of the Atlantic; the Atlantic and the New World are both long and comparatively

* The Pacific was so called by its first explorer, Magellan, in 1520, from the calm weather he enjoyed on his first voyage.

† The Atlantic received its name from the Atlas Mountains, in Barbary, which formed a prominent landmark to the early navigators of that ocean, and seemed as if presiding over its waters.

narrow, having their greatest extension from north to south. And just as the continents, as a general feature, narrow to a point on the south, so the oceans, fitting in with the configuration of the land, are broad and open at the south, and narrow towards the north.

TABLE OF DIMENSIONS OF THE OCEANS.

	Greatest Length.	Greatest Breadth.	Areas.
Pacific,‡.....	9,000 Miles.	12,000 Miles.	72,000,000 Sq. M.
Atlantic,.....	9,000 ,,	4,100 ,,	35,000,000 ,,
Indian Ocean,.	4,500 ,,	4,500 ,,	25,000,000 ,,
Arctic,.....	2,400 ,,	2,400 ,,	5,000,000 ,, ?
Antarctic, ...	3,266½ ,,	3,266½ ,,	?

19. Configuration. — The oceans have their characteristic forms and features as well as the land :—

(1) The **Pacific Ocean** presents the appearance of a rude oval, but open on the south, where it merges into the Southern Ocean. Its eastern shore presents the most extended line of unbroken coast in the world, having no considerable opening save the Gulf of California and the Bay of Panama. On the Asiatic shore, however, it is distinguished by five large land-locked seas, shut in by peninsulas and island chains: viz., the Sea of Kamtchatka, the Sea of Okhotsk, the Sea of Japan, the Yellow Sea, and the Chinese Sea. In regard to contour, the Pacific is the *ocean of land-locked seas.* But its most distinctive feature is the numberless island-forms that stud its bosom. Between the two Tropics, from north-west to south-east, a distance of 4000 miles by 1500 miles in width, extends the vast island-system of Polynesia, mostly built up from the depths below by the tiny coral-insect, working in myriads, and working for ages.

(2) The **Indian Ocean**—whilst itself assuming the form of an immense gulf, with India at its apex cleaving its

* The Pacific, called also the Great Ocean, exceeds in area all the dry land of the globe, and forms about one-half of its waters.

northern waters into the Bay of Bengal and the Arabian Sea—sends the Red Sea and the Persian Gulf far into the land on both sides of the Arabian peninsula. It has been styled the *ocean of gulfs*.

(3) The **Atlantic Ocean** extends like a winding channel between the Old World on the east and the New World on the west, opening freely at both ends into the Northern and Southern Oceans. The projections and indentations of its opposite shores correspond to each other—the one receding as the other advances. It is distinguished by the indentations of the shores of its northern basin, while those of the south are close and unbroken. It is the *ocean of inland seas*—having two on the east, the Baltic and the Mediterranean (with its extensions into the Black Sea and Sea of Azov); and two on the west, Hudson's Bay and the Gulf of Mexico. It has also the land-locked seas of the German Ocean, the Caribbean, and the Gulf of St. Lawrence. Thus closely connected by its arms with the interior of the great continents, it is the most frequented of all the oceans, and has become the great highway of nations to the civilized world. From the Azores westwards to the Bahamas extends the Sargasso, or Grassy Sea, covered with a kind of floating sea-weed, called "Gulf weed," supposed to be accumulated by the Gulf Stream. It covers an area of nearly 1,200,000 square miles, nearly ten times the size of the British Islands, and its waters are almost stagnant.

(4) and (5) The **Arctic** and **Antarctic Oceans** being so much ice-locked, are in a great measure unknown to us, having hitherto resisted all attempts to penetrate to either pole. The neighbourhood of the North Pole has by some been supposed to be open sea, but the nearest approach to it was at a distance of 500 miles (82° 55′). The skill and enterprise of the present day have burst the icy barrier of the North-West Passage to India, which had baffled the attempts of 300 years; but although thus proved to exist, the passage is of no practical value, being closely shut up by ice. The **Arctic** or **Frozen Ocean** is almost

land-locked, opening only into the Atlantic by Davis' Straits and between Greenland and Norway, and into the Pacific at the Straits of Behring. It is almost circular, being 2400 miles in diameter, and, so far as known, its surface, except near the mainland, is broken by no land save Greenland, Nova Zembla, and Spitzbergen. The **Antarctic Ocean** is still more dreary, boisterous, and inaccessible than the Arctic, and it sends its icebergs ten degrees nearer the equator. Victoria Land, the most southern land known, with its great volcanic peaks, Erebus and Terror, and shores entirely destitute of vegetation, might favour the idea of a southern continent. But no navigator has yet explored its scenes of eternal desolation nearer than 78° 10′ south latitude, or 800 miles from the southern pole.

20. Mutual Relations of Land and Water.—The general distribution and leading outlines of the terraqueous globe may serve to indicate the wise and beneficent designs of the Great Architect. All the reasons of the present arrangements we cannot pretend to know, but to state one or two of the more obvious may here suffice. In primeval times, when man had gained little or no control over wind and wave—with the two great continents only 36 miles apart at Behring's Straits, and with the great stepping-stones of the Aleutian Isles between—the present distribution of the land was perhaps the most convenient for the migrations of man. But now that the ocean is no longer dreaded as a disuniting barrier, it is the grand medium of intercourse between the different regions of the globe. Its very vastness favours the ease and frequency of the intercourse. Above all, as we shall learn more fully hereafter, the ocean is the great storehouse of warmth, moisture, and winds, which are there elaborated and sent forth, through the mutual action of land and water, to carry fertility and beauty over the face of the globe. Had the chief development of land been in the Polar or Torrid Zones, instead of the Temperate, man could never have reached his

present pitch of civilization; he must have remained for ever the half-civilized, shivering Esquimaux, or the degraded sun-burnt Negro of the Line. Were the relative areas, configurations, or positions of land and sea to be materially altered, the climate of the globe, with all its vegetable and animal forms, would be affected, and life and vegetation over extensive regions might be succeeded by sterility and death.

21. Depth.—The bed of the ocean, like the surface of the dry land, presents great inequalities—being diversified by plains, plateaux, valleys, and mountains of very varied dimensions. As a general law, low lands are bordered by shallow seas, and high lands by deep water—the gentle or abrupt slope of the adjacent shores being continued underneath the waves. The great plains of Northern Europe, Asia, and America, slope gradually into the shallow bed of the Arctic Ocean, while the abrupt terminations of Africa and South America dip suddenly into deep waters. A great plateau at the bottom of the Atlantic stretches from Ireland to Newfoundland (1600 miles), at a depth of from 1450 to 2424 fathoms, or an average depth of about 1950 fathoms. This forms the bed of the Atlantic Telegraph Cables.

"The floor of the Atlantic, as determined by deep soundings, consists of a series of descending steps, not very closely resembling the form of any of the large tracts of land now above the sea, but having more resemblance to Africa than Europe, Asia, or America. Very broad and comparatively level terraces extend for a certain distance beyond the existing shores, and are succeeded by steep cliffs dropping some 9000 feet. For a distance of 230 miles from the coast of Ireland, there is a slope of only about 6 feet in a mile (one in a thousand). In the next 20 miles there is a fall of 9000 feet (one in twelve), after which, for 1200 miles, there seems little disturbance of level. This vast terrace is one of several that appear to characterise the bottom of the great Atlantic canal. By a succession of drops we at length attain the greatest depth, about 30,000 feet, which is on the American side of the ocean, some distance south of the great bank of Newfoundland, and between the 30th and 40th parallels of latitude. At this depth, there is a basin-shaped depression, nearly 1000 miles in length."—*Ansted's Physical Geography.*

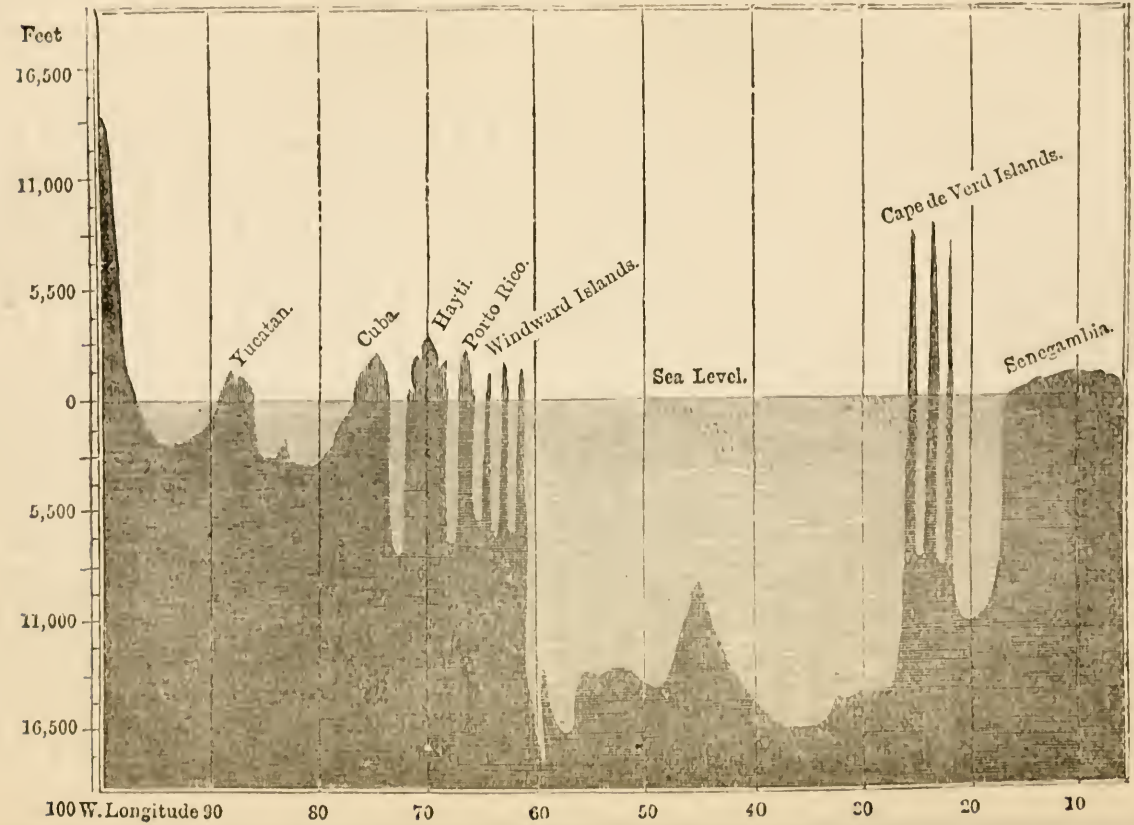
The mean depth of the ocean has been estimated at 21,000 feet, or about 4 English miles, and the extreme depth at 50,000 feet, or more than 9 miles. The Atlantic, averaging from 3 to 5 miles, is deeper than the Pacific, although 40,000 feet have been reached by soundings in the latter; the Indian and Southern Oceans are from 4 to 6 miles; the Antarctic becomes shallower towards the Pole; the Arctic is generally supposed to be the shallowest of the oceans. The minor seas exhibit much diversity of depth.

22. Quantity.—The quantity of water in the ocean (which it is impossible as yet to estimate correctly) is always the same. But taking the average depth as 4 miles, the total cubic contents of the sea have been estimated at 584 millions of cubic miles, and its mass or weight at 2,494,500 billions of tons, or one 2346th part of the total mass of the globe (5,852 trillions of tons). On the one hand it is receiving a never-ending flow of waters from the land, and on the other, the solar rays are constantly elaborating its particles into vapour; but these two processes of waste and renewal so nicely balance each other as to create no increase or diminution of its volume. It remains, over its wide expanses, everywhere at the same level; and hence the level of the sea at mean tide is assumed as the standard for the measurement of heights.

It has been roughly calculated, that if the present volume of the ocean waters were increased by $\frac{1}{4}$, the earth would be covered except the highest mountains; were it diminished by $\frac{1}{4}$, the largest rivers would dwindle to brooks, the principal branches of the ocean would be dried up, and the face of the dry land, deprived of its due proportion of moisture, would be left parched and desolate.

23. Pressure.—The pressure of the waters increasing with the depth, it was till lately supposed that at great depths no animal and vegetable life could exist, and that therefore the abysses of the great deep were as tenantless

Vertical Section of Atlantic Ocean.



and barren as the highest snow-clad summits of the land; but recent explorations have discovered the existence of numerous forms of animal life at the greatest depths. The floor of the ocean is covered in most places with ooze or soft mud; but in great depths, over thousands of square miles, with immense deposits of microscopic marine shells.

At the depth of 1000 feet, water is compressed $\frac{1}{340}$ of its bulk; at one mile of depth, the pressure is 160 times that of the atmosphere, or nearly 2400 lbs. per square inch; and so on in proportion.

24. Temperature.—Water being a slow conductor of heat, preserves a more equable temperature than the atmosphere, being, therefore, neither so warm in summer nor so cold in winter as the adjacent lands. It varies in surface temperature according to latitude,—from about 80° at and near the equator to 30° towards either Pole; but below 100 fathoms it is unaffected by solar heat or currents, and the temperature rapidly declines. Everywhere, at great depths, a uniform temperature of 35° has been found—at a depth of 7200 feet at the equator, and at 4500 feet in the highest latitudes. The mean temperature of the North Atlantic is about 71½°, and that of the South Atlantic is nearly 5° less; the North Pacific is nearly 70°, and the South Pacific 2¼° less, while the Indian Ocean is warmer than the Pacific. This equability of temperature acts as a corrective to the extremes of climate on the land: a milder air from the sea serves to soften the severities of high latitudes, while a cooling breath refreshes the drooping animal and vegetable life of tropical climes.

25. Saltness.—No quality of the ocean is more conspicuous than its saltness. Were all the salts of the sea precipitated, and spread out equally over the land, they would, it has been computed, cover the ground one mile deep over an area of 7,000,000 square miles, or nearly twice the area of Europe. This quality is owing to the presence of various ingredients held in chemical solution

in its waters—chiefly common salt, sulphate of soda, chloride of lime, and magnesia. It amounts to about 3½ per cent., or nearly half an ounce to the pound. This saltness is not quite uniform in all parts of the ocean. The waters of the Southern Ocean are slightly salter than those of the Northern; and the greatest saltness occurs along the parallels of 20° north and 17° south,—that is, in the region of the Trade Winds, which carry off an excess of fresh vapour to the Equator. Inland seas, from the influx of rivers and less evaporation, are in general fresher than the ocean: the Baltic is only half as salt; while the Red Sea, in a rainless and riverless region, has an excess of saltness. Sea-water is heavier than fresh water, which, therefore, floats on the surface. Hence the waters of the Amazon are perceived more than 200 miles out in the ocean, and fresh water has been skimmed from the surface of the sea. It also freezes less readily, not being converted into ice till the thermometer falls to 28½° Fahr., while fresh water freezes at 32°—thus keeping a larger surface open and serviceable to man. It is also less vaporizable, thus limiting the amount of moisture given off from its immense expanse to the comparatively small area of the land.

This salt, which subserves these and other important uses in the economy of nature, is chiefly derived from ingredients washed down by rivers from the soil. For the same reason, lakes that have no outlet are salt, and from constant supplies are becoming salter, as the ocean would, were its salts not taken up and secreted by the numberless shell-fish and infusoria of its waters.

26. **Colour.**—In small quantities sea-water is colourless; but in large masses it is of various shades. In the open ocean, shallow waters are green, while those of great depth are indigo blue. These colours are also due to the comparative freshness or saltness of the water: the fresher Northern Seas being light green, while the Indian Ocean in the Trade Wind region is dark blue. Other colours, peculiar to particular seas, and often giving

names to them, as Red, Black, White, Yellow, Green, and Vermilion,* are due to local causes, such as the colour of the bottom, the presence of river water in large quantities, and countless myriads of animal and vegetable organisms.

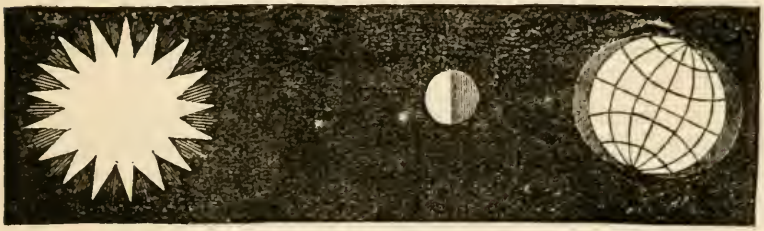
MOVEMENTS OF THE OCEAN: WAVES, TIDES, CURRENTS.

27. Waves.—Waves are undulations of the water without progressive motion. They are produced by winds, and are not sensibly felt to any great depth. They are of various magnitude, dependent on the force of the wind, from a gentle ripple to billows 40 feet in height. The greatest waves known are those off the Cape of Good Hope (formerly called the "Cape of Storms") in a north-west gale, when they measure 40 feet from trough to crest; off Cape Horn 32 feet; in the North Atlantic 20 to 25 feet; and in the British Seas 8 to 10 feet. The Polar Seas, owing to their great floating fields of ice, are never agitated by storms. The velocity and force of waves depend primarily upon the violence and continuity of the wind, but also largely upon their magnitude and the depth of water which they traverse. The velocity has been calculated of a wave 100 feet broad, over water 100 feet deep, at 15 miles an hour; with ten times these proportions at 48 miles an hour; and with 100 times these proportions at 154 miles. Their pressure is sometimes enormous, having been estimated as high as 6000 lbs. per square foot.

28. Tides.—The tides are a periodic rising and falling of the waters of the ocean, caused by the attraction of the sun and moon, but chiefly of the latter, on account of its greater proximity. The whole body of the earth is influenced, but, from their mobility, only the waters of

* The Green Sea (or Sargasso Sea) lies west of the Azores and Canary Islands, and the Vermilion Sea is a name applied to the Gulf of California.

the globe are sensibly affected. As the earth rotates on its axis, meridian after meridian is presented in succession to the attractive influence, so that the rising waters are drawn along in a great tidal wave or flow around the globe. When the sun and moon are in conjunction, that is, at full moon, the united attractions cause the highest or spring tides; but when the moon is in her quadratures, that is, in her first and last quarters, the sun's attraction acts at right angles to that of the moon, and produces the lowest or neap-tides. The moon's attractive power, compared with the sun's, is as 100 to 38, and the difference between Spring-tide and Neap-tide is as 7 to 3



THE SUN AND MOON IN CONJUNCTION, PRODUCING SPRING-TIDES.

THE SUN AND MOON IN OPPOSITION, CAUSING NEAP-TIDES.

The waters most directly under the moon being nearest, are most attracted, and rise highest; at the same time, the body of the earth also is drawn towards that luminary so as to leave the mobile waters on the opposite side of the earth behind; hence causing them to bulge out to an

equal extent with those on the other side. There are thus two **high-waters** at the same time on opposite sides of the globe,—the one above, the other beneath the horizon; while the other two sides, having their waters drawn away from them, have **low-water**. Every place, therefore, owing to the earth's rotation, would have two high-waters and two low-waters every 24 hours; but as, owing to the moon's revolution round the earth in a month, it requires 24 hours 54 minutes to bring the same meridian again beneath the moon, every successive tide is from 20 to 27 minutes later than the preceding, and the alternate tides about 50 minutes. The waters do not, however, immediately obey the moon, but from the force of inertia require an interval of three hours, at any given meridian, between the passage of the moon and high-water.

29. Tide-Waves.—Tides are highest where the earth's surface is nearest the moon, that is, between the tropics; and they gradually diminish towards the poles. Had our planet been one great globe of water, the tides would have been perfectly regular and continuous from east to west; but from the masses of land and their configuration, the course of the tidal wave is much obstructed and deflected. The Southern Ocean, an uninterrupted expanse surrounding the globe, may be regarded as the area whence arises the great tidal wave. It then presses forwards into the Pacific, Indian, and Atlantic Oceans, variously modified in its passage by the obstructions it meets with. In the Indian and Atlantic Oceans, owing to their configuration, it assumes a northerly course.

The high-water which passes Tasmania at (say) midnight reaches Ceylon in twelve hours, and Cape of Good Hope in about thirteen; it is off Newfoundland in other twelve; in twelve more it has rounded the north of Scotland and reached Aberdeen; in other twelve it is at the mouth of the Thames; and it is only on the morning of the third day that it has brought high-water to London Bridge.


ARCTIC OCEAN
ARCTIC OCEAN
Behring Strait
Greenland
ASIA
NORTH AMERICA
Arctic Current
Arctic Current
Prolongation of the Gulf Stream
Arctic Circle
EUROPE
ASIA
Japan Current
Gulf Stream
Sargasso Sea
N.th Equatorial Cur.t
Tropic of Cancer
China
Japan Current
N.th Equatorial Cur.t
Sandwich Is.
Mexican Curt
Counter Curt
Guinea Cur.t
S.th Equatorial Cur.t
AFRICA
Equator
Equator
S.th Equatorial Cur.t
Peruvian Curt
SOUTH AMERICA
Bengal & Malabar Curt
INDIAN OCEAN
Equatorial Curt
OCEAN
AUSTRALIA
AUSTRALIA
N.S. Wales Curt
Tropic of Capricorn
S.th Connecting Curt
Brazil Curt
S.th African Curt
Cape Curt
N.S. Wales Curt
New Zealand
New Zealand
Chili Curt
Counter Curt
Antarctic Drift Current
Cape Horn Curt
Antarctic Drift Current
Antarctic Circle
OCEAN CURRENTS.
Warm Currents thus
Cold " "
The Arrows indicate their direction.
J. Bartholomew, Edin.r

The **velocity** of the tide-wave is greatest where the ocean is freest and deepest. In the Southern Ocean it travels at 1000 miles an hour, in the North Sea at not more than 50. Its **height**, in broad open expanses, as in the Pacific, is only one or two feet, in the Southern Ocean five or six, in the Atlantic and Indian Oceans eight or ten; but in inlets of the sea, with broad mouths open to its advance and narrowing in the interior, such as the Bay of Bengal, Bay of Fundy, Bristol Channel, and Solway Firth, it may rise to 30, 40, or even 70 feet. In river estuaries, the tide entering and converging forms a head of water called a **Bore**, from 10 to 30 feet high in different rivers, and of great velocity and destructiveness. Such occur in the Hooghly, the Amazon, the Garonne, and the Severn. Inland seas and gulfs, as the Mediterranean and the Baltic, whose openings are narrow and not in the course of the tidal wave, have no perceptible tides; and their areas are too limited to generate any tide-waves of their own.

The South Sea Islands appear to present some remarkable exceptions to the ordinary theory of the tides: the height to which the waters rise never varies more than a few inches; and throughout the year it is uniformly low water at six in the morning and six in the evening, and high water at noon and midnight—a fact so well established that the word for high-water and for midnight is the same.

30. Currents.—The ocean currents are of three kinds: —**constant, periodical,** and **variable.** The **constant** are due primarily to the unequal temperatures and densities of the waters, and secondarily to the rotation of the earth and the Trade-Winds; the **periodical,** most common in the Indian Ocean, are caused by the tides, the monsoons, and land and sea breezes within the tropics; and the **variable** are produced by local peculiarities of tides, winds, configuration of the land and sea-bottom, the melting of polar ice, etc. **Drift-currents** are caused by the long-continued action of the wind upon the waters at

or near the surface; but deep-sea currents extend hundreds of fathoms down.

31. Causes of Currents.—Currents are necessary to maintain the equilibrium of the ocean. The waters of the equatorial regions being greatly heated, lose their specific gravity and rise to the surface, a prodigious quantity at the same time passing off by evaporation—a foot deep of water being evaporated in a few days. The waters from the Poles being colder, and therefore heavier, set in as an under current to supply their place. On the other hand, the waters of the polar regions, being condensed by cold, subside, and the warmer and therefore lighter waters from the Equator make for the Poles to restore the equilibrium in those regions. Thus two primary sets of currents are established—two light, warm, surface currents north and south from the Equator to the Poles, and two heavy, cold, under currents from the Poles to the Equator. But the latter, advancing by degrees towards the Equator, where the earth's rotation is most rapid (viz., 1000 miles per hour), cannot all at once acquire the increasing velocity, but fall behind the rest of the equatorial surface, flowing westwards, and forming the **Great Equatorial Currents.** By an opposite course of reasoning, it may be shown that currents from the Equator must have a tendency eastwards. Hence arises the great circulatory system of the ocean. By the interruptions and modifications of land, sea-bottom, and other local causes, this great flow is broken up into various minor currents of different directions, volumes, velocities, and temperatures.

The **General Law of the Directions of Ocean Currents** may be thus stated :—

(1) Within the Tropics they flow westwards.

(2) In the Temperate Zones, eastwards.

(3) In high latitudes, from the Poles to the Equator.

32. Equatorial Currents.—These may be considered as general movements of the waters of the globe from east to west, in opposition to the diurnal motion of the earth.

In their origin they are all more or less dependent upon drift currents from the Antarctic Ocean.

(1) An **Antarctic Drift Current** to the north-east strikes against the shores of South America, and flows northwards till it reaches Peru, when it turns westwards as part of the great **Equatorial Current of the Pacific.** In a belt 3500 miles wide, that is, the entire Torrid Zone, the latter sweeps boldly across to the Indian Archipelago and South-Eastern Asia. The **Japan Current,** known to the Japanese as the Kuro-Siwo, or Black Stream, is here set off to the north-east, bearing its warm waters into the North Pacific, and the **New South Wales** and **New Zealand Currents** to the south, while a considerable portion returns to the east as a counter-current.

(2) The **Equatorial Current of the Indian Ocean** makes its way across to Africa, by which it is deflected to the south. From the obstruction of the Agulhas Bank, off the Cape of Good Hope, the main portion is turned back, and helps to form the **Counter Current of the Indian Ocean,** which, with a speed of 50 miles a-day, and along the direct route from the Cape to Australia, is of important service to navigation.

(3) The **South African Current,** proceeding northwards, joins the **Equatorial Current of the Atlantic,** which, at 300 or 400 miles off Cape St. Roque, divides into two main branches—the **Brazil Current,** south-west along the South American coast, and the **Guiana Current,** north-west into the Caribbean Sea and Gulf of Mexico.

33. The Gulf Stream.—The most remarkable of all the oceanic currents is the Gulf Stream, so called from its origin in the Gulf of Mexico. Formed by the accumulated waters of the Equatorial Current in the confined basin of this gulf, it rushes out through the narrow Channel of Florida, and flows north-east almost parallel to the coast of North America, till it reaches the Great Bank of Newfoundland. Thence it spreads out across the Atlantic, part of its waters turning southwards by the

Azores, again to join the Equatorial Current;* but the greater part proceeding north-east, bathes the British Isles and the shores of Norway, and ultimately loses itself in the Arctic Ocean. This great "river in the ocean," from the Gulf of Mexico to the Azores, is 3000 miles in length, and its greatest breadth 120. At first its speed is 4 miles an hour; but this gradually declines as it becomes more diffused. In the Strait of Florida its temperature is 86°, or 9° above the surrounding waters; and off Newfoundland, in winter, it is 25° to 30° warmer than the neighbouring seas, thus causing the dense fogs of that region. It is a great dispenser of heat and moisture in its course. To its influence is owing the verdure of the "Emerald Isle," and the mildness of the climate of Western Europe compared with countries elsewhere of corresponding latitudes. It arrests the chilling Arctic icebergs, which melt away in its tepid waters. It is of a deep indigo blue as long as its current is deep and narrow; and the line of demarcation between it and the adjacent waters is so marked, that a vessel may be seen floating one half in the Gulf Stream, and the other in the common water of the sea; and two buckets let down, one at the bow, the other at the stern, will draw up water differing in temperature by no less than 30°.

34. **The Arctic Current.**—Just as a cold Antarctic current flows into the Pacific, a cold Arctic current flows into the Atlantic. A united stream from the east and west sides of Greenland presses strongly south till it meets the Gulf Stream off Newfoundland, sending its icebergs far into the Atlantic. Here it divides—one portion flowing south as an under current to the Caribbean Sea, and the other south-west along the shores of the United States. Whilst the Gulf Stream warms the coasts of Europe, the Arctic Current cools those of America, producing a marked climatic contrast between the opposite shores of

* It was the wreck cast ashore on the Azores by this current that suggested to Columbus the idea of land to the west, which led to the discovery of America.

the Atlantic; but it affords an excellent supply of fish denied to warmer seas. "It replaces the warm water sent through the Gulf Stream, and modifies the climate of Central America and the Gulf of Mexico, which, but for this beautiful and benign system of aqueous circulation, would be one of the hottest and most pestilential in the world."

35. Uses of Currents.—These great ever-flowing ocean streams preserve the equilibrium of the sea by the constant interchange of waters, and thus maintain the almost uniform saltness, and therefore the purity and salubrity of the ocean; they soften the extremes of climate in different regions of the earth, by imparting to them the temperature of their own waters; and by facilitating the course of the navigator, who learns to take advantage of them, they promote the progress of commerce and civilization.

PRINCIPAL OCEAN CURRENTS.

	Direction.*		Direction.
PACIFIC OCEAN.			
Antarctic Drift Current, . . . flowing	N.E.	Japan Current, or Kuro-Siwo, . . flowing	N.E.
Cape Horn Current, ,,	E.	New South Wales Current, ... ,,	S.
Peruvian, Chili, or Humboldt's Current, ,,	N.	Mexican Current:	
Equatorial Current, . ,,	W.	in winter half-year. ,,	S.E.
		in summer half-year. ,,	N.W.
INDIAN OCEAN.			
Equatorial Current, . flowing	W.	Agulhas or Cape Current, . . . flowing	W.
Mozambique Current, ,,	S.	Counter Current, . ,,	E.
ATLANTIC OCEAN.			
Equatorial Current, . flowing	W.	North African and Guinea Current, . flowing	S.
Brazil Current, . . ,,	S.W.	Arctic or Greenland Current, ... ,,	S
Guiana Current, . . ,,	N.W.		
Gulf Stream, . . ,,	N.E.		

* Currents are named after the direction *to* which they flow; thus, an easterly current is one flowing towards the east; winds, on the other hand, are named after the direction *from* which they blow.

EXERCISES.

1. What are the relative proportions of the areas of the oceans to each other? Draw out a comparative view of these areas similar to that of the continents on page 18, and on the same scale. Compare them with that of the British Islands. Why is the area of the Antarctic Ocean not stated in the Table, page 50? Where is the Atlantic broadest? where narrowest? Name the peninsulas and island chains that shut in the seas on the east of Asia. Name the projections that look across to indentations on the opposite shores of the Atlantic. Which countries on the Atlantic are most worn by its waters into fiords, firths, or lochs? Name similar inlets on the shores of the Pacific. What islands or peninsulas shut in the North Sea? the Caribbean? the Gulf of St. Lawrence? the Mediterranean? the Baltic? Gulf of Mexico? and Hudson's Bay? Write out a descriptive account of the Distribution of Water. Draw a map of the two Hemispheres.

2. Name the seas or oceans which you would expect to be shallow, and those you would expect to be deep,—and state why. Compare the greatest and the mean height of the land of the globe with the greatest and the mean depth of the ocean. Point out the seas named after colours, and account, if you can, for the name of each. Name and point out as many rivers as you can named after the colour of their waters, and account, if you can, for the different colours.

3. Could you illustrate by a simple experiment the reason why the Polar seas are comparatively so calm? In what respect do waves, tides, and currents differ essentially from each other? Write out in your own words a descriptive account of tides. Which are cold currents? and which are warm? Which currents branch off from the Equatorial currents? and which join them? Which currents meet each other? Which should be most serviceable to a vessel bound from Britain to Australia? and which on her return voyage? What portion of the ocean is surrounded by the Gulf Stream? Which current of the Pacific corresponds to the Gulf Stream in the Atlantic? Write out in your own words a descriptive account of the Gulf Stream. Draw a map of the Ocean Currents.

CHAPTER IV.

WATERS OF THE LAND.

Springs — Rivers — Characteristics of Rivers — Classification of Rivers—River-Sources—River-Basins—Velocity of Rivers—Waterfalls — River-Mouths — Floods of Rivers — Table of River-Systems—Lakes—Characteristics of Lakes—Classification of Lakes—Distribution of Lakes—Table of Principal Lakes.

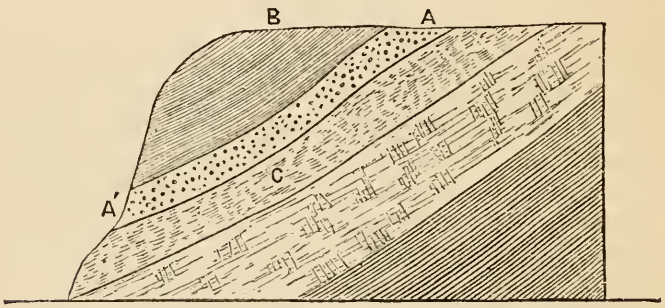
SPRINGS.

36. Of the rain which falls upon the surface of the earth, one large portion runs off in streams back to the ocean, from which it originally came, another is evaporated into the atmosphere, while a third soaks into the soil, and seeks a way to a greater or less distance into the bowels of the earth, but afterwards reappears at the surface in what are called **Springs.** These springs are of three kinds, viz., **Land Springs, Transtratic Springs,** and **Deep-seated Springs.**

(1) **Land Springs** are derived from the waters which have accumulated near the surface, having soaked down through a pervious layer, such as sand or gravel, been intercepted by an impervious one like clay, and collected in its irregularities or hollows. Such springs yield the supply to many of our wells, but they are liable to fail in a dry season, and to be tainted with impurities from the surface.

(2) **Transtratic Springs,** as they have been recently called, are those that yield their waters at a considerable distance from their place of reception, having been conveyed thither *through a stratum* of a porous character lying between two which are impervious. The water has been received as rain at the surface A (see annexed fig.) lying between two impervious rocks, B and C; it makes its way through the stratum till it reappears at A′ in the form of a spring. Such often well forth by the margin

of a river, at the bottom of a valley, or on the green soft turf on the mountain side. If an opening is sunk from B to the water-bearing rock A A′, the water will rise to the level of its source. Such is the principle of **Artesian wells**, by which water is raised from great depths. But the water often finds its way up naturally by means of faults or fractures in the overlying rock. This is the most numerous and copious class of springs, and they are frequently uniform in temperature and regular in quantity.



(3) **Deep-seated Springs** derive their waters from a great depth by means of cracks or crevices in the rocks. They generally contain a greater or less quantity of foreign matter derived by solution from the rocks through which they have passed, and often imparting to them valuable medicinal qualities. The quantity of solid matter varies from $\frac{1}{20}$ of an ounce to 16 ounces per gallon, and the general name by which they are known is **mineral springs.** They may be *saline* or salt, as at Epsom, *chalybeate* or iron, as at Tunbridge Wells, *sulphurous*, as at Harrowgate, *silicious* or flinty, as the Geysers of Iceland, *calcareous* or limy, as in Italy, and *carbonated* or abounding with carbonic acid, as at Auvergne in France. If the water is warm, the springs are termed *thermal*, showing they have sprung from a great depth, where the temperature is so much greater than at the surface. Most thermal springs are below 100°F., but they may equal or

even exceed the temperature of boiling water (212°), as in the Geysers. Indeed, these springs are found most plentifully in regions which are, or have been, the seats of volcanic agency.

RIVERS.

37. Characteristics of Rivers.—Rivers are the great agencies of nature for carrying the superfluous moisture off the face of the land. It has been estimated that only about $^1/_3$ of the aqueous deposits of the atmosphere finds its way back directly to the ocean, its original repository —the rest being applied to the support of animal and vegetable life, or carried off by evaporation. Rivers irrigate as well as drain the soil, and carry off impurities and debris to the ocean. They are, besides, important agents in the commercial and social economy of nations, forming ready and effective means of intercourse. But for great rivers the interior of the continents would have been impassable wilds, shut out from civilization. The banks of rivers are the sites of most of the great cities of the world; and the seats of commercial and manufacturing industry are almost invariably grouped along their course.

38. Classification of Rivers.—Rivers are either **Oceanic** or **Continental.**

(1) **Oceanic rivers** are those which flow into the ocean directly or indirectly. About 440 considerable rivers of this class are found in the Old World, and about 140 in the New; but many of those in the New World are of greater length and volume. From the vertical configuration of the globe, already explained, the chief slopes in both worlds are towards the Arctic and Atlantic basins, while the Pacific, though the largest ocean, receives but few rivers. With two or three exceptions, all the large rivers of the world are in the Northern Hemisphere; the Amazon belongs to both sides of the Equator. The most important rivers of the globe have an easterly course, while those with a westerly course are unimportant.

(2) **Continental rivers** are those which do not reach the ocean, but are confined to the continent, discharging their waters into inland lakes with no outlet, or losing themselves, through evaporation, in sands or marshes. In the Old World is an extensive **Basin of Continental Streams,** extending from near the Baltic and Black Seas through the whole of Inner Asia eastwards to near the Yellow Sea. It comprises the Volga, the largest river of Europe, the depressed regions around the Caspian Sea and Sea of Aral, and the great table-land of Central Asia, and is 3,000,000 square miles in area. Similar regions, but of limited extent, are the **Basins of the Dead Sea, Utah, the Mexican Table-land,** and the **Plateau of Bolivia, a district in Morocco** south of the Atlas range, and, perhaps, also the **Basin of Lake Tchad** in Central Africa.

39. **River-systems.**—Rivers are commonly grouped into **river-systems,** according to the oceanic or continental basin into which they descend, whether directly or indirectly. The widest generalization of this kind, therefore, will be into four great oceanic systems, and into the several minor continental ones which belong to the continental basins just indicated. For the different river-systems of the globe, see pages 76-9.

A **binary river-system** consists of two rivers which rise near each other, pursue a divergent course, though in the same general direction, and finally join or fall into the same sea, such as the Euphrates and Tigris.

40. **River-sources.**—Rivers in general take their rise in springs or lakes, and sometimes from the melting of snows and glaciers. Some, like the Ganges, issue at once from a glacier a large river; but most swell by degrees from tiny rills. Most large rivers have their head-waters in high lands, but the water-shed of a country is often of no great elevation, as, for example, the swamps of Russia in the Great Plain of Europe, and the north of North America, where the sources of rivers flowing in opposite directions are so low as to be united in times of flood, or

permanently by means of lakes. The head-waters of the Mississippi are thus connected with the southern tributaries of Lake Winnipeg, and the River Illinois with Lake Michigan; Lake Athabasca and Lake Wollaston are connected with both the Arctic Ocean and Hudson's Bay. The Orinoco in South America sends off a branch, the Casiquiare, which, after a course of 180 miles, joins the Rio Negro, a leading tributary of the Amazon. The Zambesi and the Congo both rise in Lake Dilolo in Central Africa, and thus unite the Indian and the Atlantic Oceans.

41. River-basins. — A river and its tributaries, or affluents, are distributed like the stem and branches of a tree, or the veins and arteries of the body; and the whole area over which they are spread is termed the **river-basin.**

LARGEST RIVER-BASINS.

RIVER-BASIN.	Area in Sq. Miles.
EUROPE.	
Volga,	520,000
Danube,	310,000
Don,	205,000
Dnieper,	200,000
Northern Dwina,	144,000
Neva,	91,000
Rhine,	87,000
Vistula,	76,000
Elbe,	57,000
Oder,	53,000
ASIA.	
Obi,	1,250,000
Yenisei,	1,110,000
Lena,	960,000
Amoor,	900,000
Yang-tse-kiang,	760,000
Ganges,	420,000
Indus,	400,000
Hoangho,	400,000
Brahmaputra,	350,000
Sir-daria,	320,000
Tigris and Euphrates,	230,000
Tarim,	240,000
AFRICA.*	
Nile,	520,000
Zambesi,	432,000
AUSTRALIA.	
Murray,	250,000
NORTH AMERICA.	
Mississippi,	1,244,000
Mackenzie and Athabasca,	600,000
Saskatchewan and Nelson,	490,000
St. Lawrence,	400,000
Columbia,	268,000
Rio Grande,	250,000
Rio Colorado,	230,000
SOUTH AMERICA.	
Amazon,	2,000,000
La Plata (Parana, &c.),	1,200,000
Orinoco,	337,000
San Francisco,	250,000

* The interior of Africa being as yet imperfectly explored, no sufficient estimate of the extent of most of its river-basins can be made.

The extent of basin is one of the most important elements in estimating the importance of a river. Of the larger rivers the largest basins are in America, and the smallest in Europe. The Amazon has the largest basin and volume, and the Mississippi-Missouri the longest course (4382 miles).

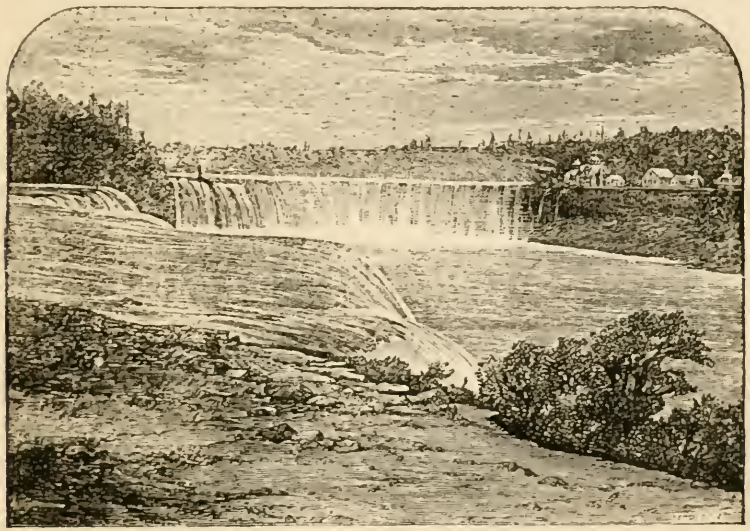
The Amazon (4000 miles in length) has a basin of 2,000,000 square miles (more than half of Europe), with 50,000 miles of navigation. It has more than twenty tributaries, navigable almost to their sources, and equal in size to the largest rivers of Europe. Near its mouth it is 180 miles wide; tides ascend for 400 miles from the Atlantic; and its fresh-water current is perceived 200 miles out at sea.

42. The **velocity** of a river depends chiefly upon the declivity of its basin, the form of the channel, and the volume of water; but the average rate is from three to four miles an hour in the lower course. But the fall is greatest in the upper course, where the stream is only a mountain torrent and unnavigable. Winding rivers have the slowest current. Were it not for the friction of the banks and bottom, the accelerating force of gravity would increase the velocity to an alarming degree. Thus, the Thames, falling 100 feet in 250 miles, would run with a speed of 54 miles an hour; and the Rhone, falling 900 feet in 645 miles, at 164 miles an hour. Of large rivers, the Volga has the least fall—633 feet in 2400 miles; the Ganges the greatest—13,800 feet in 1500 miles. For 400 miles from its mouth the Amazon falls $\frac{1}{10}$ of an inch per mile, and the Plata $\frac{1}{33}$ of an inch.

43. **Waterfalls.**—A declivity of 1 foot in 200 renders a river unnavigable; a greater slope forms **rapids**; and a perpendicular descent a **cascade** or **cataract**. The most celebrated falls are those of Niagara in North America; but they are far surpassed in breadth and volume of water by the Victoria Falls on the Zambesi, in South Africa.

The **Falls of Niagara** are formed by the River Niagara (a section of the River St. Lawrence so called), which

unites Lakes Erie and Ontario. They consist of two cataracts, separated by Goat Island, viz., the Horse-shoe Fall, on the Canadian side, 1800 feet wide, and 154 in perpendicular depth; and the American Falls, 600 feet in breadth, and 163 in depth. It is estimated that the falls discharge 700,000 tons of water per minute; their noise may be heard miles off, and the clouds of spray thrown up may be seen at a distance of many miles.



FALLS OF NIAGARA.

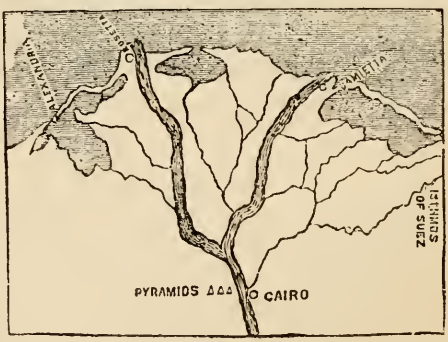
The Victoria Falls are described by Dr Livingstone, who discovered them, as the most wonderful sight he had witnessed in Africa. The Zambesi, 1000 yards wide, plunges at a single leap into a chasm 100 feet deep, and extending right across the river-bed, and then rushes away at right angles to its former course for a distance of 30 miles, enclosed between deep basaltic rocks not more than 100 feet apart. The native name, Mosioatunya ("smoke sounds there"), refers to five singular columns of dense spray that rise above the falls.

The following are some of the most remarkable waterfalls :—

	Total Height.
Orco Falls, at Monte Rosa (Alps),	2400 feet.
Gavarnie, on a small stream in the Pyrenees,	1400 ,,
Staubbach, near Lauterbrunnen, Switzerland,	1000 ,,
Maanelvan, in Norway,	940 ,,
Velino, near Terni, in Italy (artificial),	500 ,,
Tivoli, on the Teverone, 18 miles N.E. of Rome (artificial),	80 ,,
Rheinfall, on the Rhine at Schaffhausen,	70 ,,
Falls of Clyde, three in number, Scotland, highest	84 ,,
Victoria Falls, or Mosioatunya, on the Zambesi,	100 ,,
Murchison Falls, on the Nile (between Victoria and Albert N'yanza,)	120 ,,
Montmorenci Falls, 8 miles from Quebec (60 feet broad),	250 ,,
Niagara Falls, on the River Niagara, 154 and	163 ,,
Missouri (Great Falls), five in number, highest	75 ,,
Falls of the Madeira, in Brazil (½-mile broad), 19 in number, highest	100 ,,

"The loftiest waterfall in the world (unless exaggerated) is to be found in the Yohamite Valley, in Mariposa County, California, where a river, as large as the Thames at Richmond, makes a single leap of 2100 perpendicular feet, the total height of the fall being 3100 feet."

44. River Mouths.—When the coast is high and rocky, rivers fall into the sea by a single deep channel or estuary, like the **firths** of Scotland and the **fiords** of Norway.



DELTA OF THE NILE.

When the coast is low, the soil washed down by rivers which traverse alluvial plains is deposited near their mouths as the current slackens, and, accumulating for

ages, forms **deltas**, so called from their resemblance to the Greek letter Δ (called *Delta.*) The river finds its way through the deposited alluvium by means of numerous channels. The **deltas of the Nile, the Ganges, and the Mississippi**, are the most famous.

The Delta of the Ganges is 300 miles in length, and 22,000 square miles in area. The river, ¼ of whose volume consists of earthy matter, annually deposits sediment equal to 42 times the Great Pyramid of Egypt. The black mud with which the Nile, when in flood, is loaded, and which is spread out over the valley to fertilize it, or carried out to sea, amounts in one year to 140,000,000 tons. The Hoang-ho, or Yellow River, traversing the great alluvial plain of China, discharges in one hour 2,000,000 cubic feet of earth.

45. Floods of Rivers.—Rivers are subject to inundations either **occasional** or **periodical**. The former prevail in temperate latitudes, and are caused by heavy rainfalls, the rapid melting of snows in spring, and the like. The **periodical** inundations characterise the rivers of tropical regions, and are either **annual** or **semi-annual**. The **annual** inundations are due to the heavy tropical rains of certain seasons of the year. In rivers north of the equator, as the Nile, the Niger, the Ganges, and the Orinoco, the flood is at its height in August; but in those south of the equator, as the Amazon, the height is attained in March. The **semi-annual** floods are due at the one season to periodic rains, and in the other to the melting of snows in the mountain-region of their head-waters. The Tigris and the Mississippi are thus flooded. These periodic floods occur with wonderful regularity both in time and amount of overflow. In tropical countries many rivers exist only in the rainy season, as in South Africa and Australia: their dry beds are known as **nullahs** in India, **wadies** in Arabia, and **creeks** in Australia.

In tropical countries, rivers which rise in the regions of perpetual snow experience a *daily* flood, caused by the melting of snows by the solar rays; while some in Peru and Chili, being fed entirely in this way, exist only in the day-time, and are dried up during the night.

PRINCIPAL RIVERS OF THE GLOBE.

System.	River.	Source.	Course.	Position of Basin.	Mouth.	Length.
			EUROPE.			
			I.—NORTH-WESTERN SLOPE.			Miles.
Arctic,	Petchora,	Ural Mountains,	N.W.,	N.E. of Russia,	Arctic Ocean,	900
	Northern Dwina,	Great Plain,	N.W.,	N. of ,,	White Sea,	700
Baltic,	Düna, or S. Dwina,	Valdai Hills,	W.,	W. of ,,	Gulf of Riga,	490
	Niemen,	Great Plain,	W.,	W. of ,,	Curische Haff,	450
	Vistula,	Carpathians,	N., W., & N.,	Poland and E. of Prussia,	Gulf of Danzig and Frische Haff,	590
	Oder,	,,	N.W.,	Centre of Prussia,	Stettiner Haff,	455
North Sea,	Elbe,	Riesengebirge Mts. (Bohemia),	N.W.,	Bohemia and Prussia,	North Sea,	550
	Rhine,	Central Alps,	W., N., & W.,	Switzerland, Germany, and Holland,	,,	800
	Meuse,	Vosges Mountains (France),	N. & W.,	France, Belgium, Holland,	,,	450
	Thames,	West of England,	E.,	S. of England,	,,	250
Atlantic,	Seine,	East of France,	N.W.,	N. of France,	English Channel,	470
	Loire,	Cevennes Mts.,	N. & W.,	Centre of France,	Bay of Biscay,	530
	Garonne,	Pyrenees,	N.W.,	S.W. of ,,	,,	300
	Douro,	N.E. of Spain,	W.,	N. of Spain and Portugal,	Atlantic,	400
	Tagus,	East of Spain,	W.,	Centre of ,,	,,	540
			II.—SOUTH-EASTERN SLOPE.			
Mediterranean,	Ebro,	North of Spain,	S.E.	N.E. of Spain,	Mediterranean Sea,	340
	Rhone,	Central Alps,	W. & S.	Switzerland and France,	Gulf of Lions,	645
	Po,	Western Alps,	E.	Northern Italy,	Adriatic Sea,	390
Black Sea,	Danube,	S.W. of Germany,	E. S. & E.	Germany, Austria, Turkey,	Black Sea,	1725
	Dniester,	Carpathians,	S.E.	S.W. of Russia,	,,	500
	Dnieper,	Centre of Russia,	S.E.	S.W. of ,,	,,	1230
	Don,	,,	S.	S. of ,,	Sea of Azov,	1000
Caspian,	Volga,	Valdai Hills,	E. & S.	Centre and S.E. of Russia,	Caspian Sea,	2400
	Ural,	Ural Mountains,	S.	Frontiers of Europe & Asia,	,,	1040

PRINCIPAL RIVERS OF THE GLOBE—*continued.*

System.	River.	Source.	Course.	Position of Basin.	Mouth.	Length.
			ASIA.			
			I.—NORTHERN SLOPE.			Miles.
Arctic,	Lena,	W. of Lake Baikal,	N.E. & N.,	Eastern Siberia,	Arctic Ocean,	2550
	Yenisei,	Mongolia,	N.	Central Siberia,	Bay of Yenisei,	3400
	Obi,	Altai Mountains,	N.W. & W.,	Western Siberia,	Gulf of Obi,	2000
			II.—SOUTHERN SLOPE.			
Indian Ocean,	Euphrates,	Armenian Mts.,	W. & S.E.,	East of Turkey,	Persian Gulf,	1800
	Tigris,	,,	S.E.	,,	Euphrates,	1150
	Indus,	Tibet,	N.W. & S.,	Tibet and West of India,	Arabian Sea,	1800
	Ganges,	Himalayas,	S.E.,	North of India,	Bay of Bengal,	1514
	Brahmaputra,	Tibet,	E. & W.,	Tibet and N.E. of India,	,,	1300
	Irrawady,	Borders of Tibet,	S.,	Burmah and Pegu,	Gulf of Martaban,	1200
	Saluen,	,,	S.,	,, ,,	,,	950
Pacific,	Meinam,	Borders of China,	S.,	Siam,	Gulf of Siam,	850
	Mekong,	,,	S.,	Annam,	Chinese Sea,	1700
			III.—EASTERN SLOPE.			
Pacific,	Yang-tse-kiang,	Tibet,	E.	Central China,	Yellow Sea,	3600
	Hoang-ho,	,,	E.	Northern China,	,,	2600
	Amoor, or Saghalien,	North of Mongolia,	E.	S.E. of Siberia and N. of Manchooria,	Gulf of Tartary,	2640
Continental,	Sir-daria, or Sihoon,	Thian Shan Mts.,	W.	Turkestan,	Sea of Aral,	1200
	Amoo, or Oxus,	Lake Sir-i-Kol,	N.W.	,,	,,	1300
	Tarim, or Ergheu,	Bolor Tagh and Karakorum Mts.,	E.	Chinese Turkestan,	Lake Lob-nor,	1000
	Kur,	Caucasus Mts.,	E.	Georgia,	Caspian Sea,	520
	Helmund,	N.E. of Afghanistan,	S.W.	S.W. of Afghanistan,	Lake Hamoon or Zurrah,	650
	Jordan,	Mount Lebanon,	S.	Palestine,	Dead Sea,	200

PRINCIPAL RIVERS OF THE GLOBE—*continued.*

System.	River.	Source.	Course.	Position of Basin.	Mouth.	Length.
						Miles.
AFRICA.						
I.—NORTHERN SLOPE.						
Mediterranean,	Nile,	Victoria N'yanza, & Albert N'yanza,	N.,	Central Africa, Nubia, and Egypt,	Mediterranean Sea,	3766
II.—WESTERN SLOPE.						
Atlantic,	Senegal,	Kong Mountains,	N.W. & N.,	North of Senegambia,	Atlantic,	1000
	Gambia,	,,	N.W.,	Central Senegambia,	,,	550
	Niger or Joliba,	,,	N.E. & S.E.,	Soudan and Upper Guinea,	Gulf of Guinea,	3500
	Zaire, or Congo,	Lake Dilolo,	N. & W.,	Lower Guinea,	Atlantic,	1000 ?
	Orange River,	Nieuveldt Mts.,	W.,	Cape Colony and Country of Hottentots,	,,	1000
III.—EASTERN SLOPE.						
Indian Ocean,	Zambesi,	Lake Dilolo,	S. & E.,	South Central Africa,	Channel of Mozambique,	2400
NORTH AMERICA.						
I.—NORTHERN SLOPE.						
Arctic,	Saskatchewan and Nelson,	Rocky Mountains,	E. & N.E.,	Hudson's Bay Territory,	Hudson's Bay,	1300
	Churchill,	Centre of Northern Plain,	,,	,,	,,	1100
	Athabasca and Mackenzie,	Rocky Mountains,	N. & N.W.,	British America,	Arctic Ocean,	2300
II.—WESTERN SLOPE.						
Pacific,	Youcon,	Rocky Mountains,	W.,	Alaska,	Behring Sea,	1200
	Fraser,	,,	W. & S.,	British Columbia,	Gulf of Georgia,	740
	Columbia, or Oregon River,	,,	S. & W.,	N.W. of United States,	Pacific Ocean,	1200
	Rio Colorado,	,,	S. W.,	Upper California,	Gulf of California,	700

PRINCIPAL RIVERS OF THE GLOBE—*continued.*

System.	River.	Source.	Course.	Position of Basin.	Mouth.	Length.
		NORTH AMERICA—*continued.* III.—SOUTHERN SLOPE.				Miles.
Gulf of Mexico,	Rio Grande del Norte,	Rocky Mountains,	S.E.,	Texas (United States),	Gulf of Mexico,	1800
	Mississippi,	Lake Itasca (Minnesota),	S.,	Centre of United States,	,,	3160
	Missouri,	Rocky Mountains,	S.E.,	N.W. of Mississippi Valley,	Mississippi,	3096
	Arkanzas,	,,	E.S.E.,	S.W. of ,,	,,	2170
	Red River,	North of Texas,	S.E.,	S.W. of ,,	,,	1200
	Ohio,	Alleghany Mts.,	S.W.,	N.E. of ,,	,,	1265
	Tennessee,	,,	W.,	E. of ,,	Ohio,	1100
		IV.—EASTERN SLOPE.				
Atlantic,	Potomac,	Alleghany Mts.,	S.E.,	East of United States,	Chesapeake Bay,	550
	Susquehanna,	,,	,,	Pennsylvania (U. S.),	,,	500
	Hudson,	New York State,	S.,	New York State,	New York Harbour,	300
	St. Lawrence,	W. of Lake Superior,	E. & N.E.,	British America and U. S.,	G. of St. Lawrence,	2150
		SOUTH AMERICA.				
		I.—NORTHERN SLOPE.				
Caribbean,	Magdalena,	Andes near Ecuador,	N.,	Granadian Confederation,	Caribbean Sea,	840
		II.—EASTERN SLOPE.				
Atlantic,	Orinoco,	Parimé Mountains,	W., N., & E.,	Venezuela,	Atlantic,	1200
	Amazon,	Andes of Peru,	E.,	Peru, Ecuador, and Brazil,	,,	4000
	San Francisco,	S.E. of Brazil,	N. & E.,	East of Brazil,	,,	1080
		III.—SOUTHERN SLOPE.				
Atlantic,	Parana,	S.E. of Brazil,	S.W. & S.,	Brazil, Paraguay, & La Plata,	Rio de la Plata,	1800
	Paraguay,	W. of ,,	S.,	,, ,, ,,	,,	1420
	Uruguay,	S. of ,,	W. & S.,	,, Uruguay, ,,	,,	1000
		OCEANIA.				
Australian,	Murray,	Australian Alps,	W., N., & S.,	New South Wales, Victoria, and South Australia,	Indian Ocean,	1060

LAKES.

46. Characteristics.—Lakes are collections of water which are formed in the hollows or depressions of the surface of the land, and may thus be of all sizes, from the merest pools to areas of many thousand square miles. They are found in all regions, but more abundantly in mountain regions, or on the lower reaches of great plains. The highland lakes generally occupy the deep narrow troughs of mountain glens, and are frequently distinguished for their picturesque scenery; the lowland lakes are in general tame and unattractive, and closely connected in character with marsh or morass. From the limited evaporation, lakes are more numerous in high than in low latitudes; hence their frequency and magnitude in the north of Europe, Asia, and America. On the other hand, in the plains of South America, Africa, and Australia, many lakes of large area in the rainy season disappear wholly or partially in the periods of drought.

47. Classification of Lakes.—Lakes are divided into four kinds :—

(1) Those which both receive and give out waters;
(2) Those which receive, but do not give out waters;
(3) Those which give out, but do not receive waters;
(4) Those which neither receive nor give out waters.

The **first** class are the ordinary ones, being either mere expansions of a river in its course, or the receptacle of its head-waters, from which it issues as a distinct river. The great Canadian lakes are but expansions of the River St. Lawrence, and Lake Victoria N'yanza and Lake Albert N'yanza are the basins which collect the head-waters of the Nile.

The **second** class are those which receive *continental* rivers, such as the Caspian, the Aral, and the Dead Sea. The waste of water by evaporation is supposed to equal that supplied by their feeders. Their waters are almost

invariably salt or brackish—Lake Tchad forming the most prominent exception.

Lake Elton (130 miles in area), situated in the Steppe, 70 miles east of the River Volga, has the saltest (and therefore most buoyant) water in the world; and next to it is the Dead Sea in Syria. The former has 29 per cent. of saline matter in its waters, the latter has $26\frac{1}{4}$, while the ocean has only 4 per cent. The Dead Sea waters are excessively bitter and nauseous, and irritate the skin; they cannot support animal life, except in its lowest forms; and they are so buoyant that bathers float without effort on the surface.

The **third** class are fed by springs from the bottom and margins.

The **fourth** class are also fed by subterranean springs and rain; and evaporation prevents such an accumulation of water as would overflow its basin, and thus form a river. These are generally of small size, and sometimes occupy the craters of extinct volcanoes.

46. Distribution of Lakes.—North America excels every other continent in the number combined with the magnitude of its lakes. Its chain of "fresh-water seas" along the course of the St. Lawrence, and its net-work of lakes in the far north, are without parallel. The Five Great Lakes alone cover 93,000 sq. miles. Lake Victoria N'yanza (230 miles in length by the same breadth) is perhaps the largest fresh-water lake in the world; a pre-eminence which was, till recently, accorded to Lake Superior in North America. Sir-i-Kol, the source of the River Oxus in Central Asia, is 15,600 feet above the sea (nearly as high as Mont Blanc), being the highest known. The Dead Sea lies 1312 feet below the level of the Mediterranean.

47. Uses of Lakes.—Lakes are cisterns or reservoirs which serve as regulators of the discharge of rivers—preventing a too rapid overflow, which might cause destructive inundations, and retaining for summer use the superabundance of the winter supplies. They expose a larger surface to evaporation than the waters of their respective regions would otherwise afford, and they thus serve to temper with

moisture aridity of climate. They also serve to purify the rivers which they feed, by allowing the sediment or debris contained in the waters they receive to settle in their depths.

PRINCIPAL LAKES IN THE WORLD.

SYSTEM.	LAKES.	POSITION.
	EUROPE.	
Northern or Baltic,	Ladoga, Onega, Peipus, Saima; Enara, &c.,	N. W. of Russia.
	Wener, Wetter, Mælar, Hielmar, &c.,	Sweden.
Southern or Alpine,	L. of Geneva, or Leman, Neufchatel, Lucerne, Zurich, Constance, or Boden See, &c.,	Switzerland.
	Maggiore, Como, Garda, &c.,	North of Italy.
	Balaton, or Platten See, Neusiedler,	Hungary.
	ASIA.	
Northern, Eastern,	Baikal, Kosgol; Zaisan,	Siberia, Mongolia.
	Tong-ting, and Po-yang,	China.
Continental Basin,	Caspian Sea, and Lake Aral,	Turkestan, &c.
	Dead Sea; Van, Urumiah,	Syria, Armenia.
	Hamoon, or Zurrah,	Afghanistan.
	Balkash, Issyk-kul, Ubsa; Lob-nor; Sir-i-kol; Tengri, Palte; Ko-ko-nor,	Central Asia.
	AFRICA.	
Central,	Victoria N'yanza, Albert N'yanza, Tanganyika,	Central Africa.
Northern,	Dembea, or Tzana,	Abyssinia.
	Alsibkah, Melgig; Debo, or Dibbie, Tchad,	Barbary, Soudan.
Southern,	Dilolo, Shuia, Shirwa, N'yassi, N'gami,	Zambesi Basin.
	NORTH AMERICA.	
Northern,	Great Bear Lake, Great Slave Lake, Athabasca, Wollaston, Deer Lake, Winnipeg, &c.,	British America.
	Superior, Huron, Michigan, Erie, Ontario,	St. Lawrence Basin.
Southern,	Chapala; Nicaragua, Leon,	Mexico, Central Amer.
Continental Basin,	Great Salt Lake, Lake Utah,	Great Basin of Utah.
	SOUTH AMERICA.	
	Lake Maracaybo,	N. W. of Venezuela.
	Titicaca,	Bolivia.
	Lago dos Patos,	South of Brazil.
	Guanacache, Silvero, &c.,	La Plata.
	AUSTRALIA.	
	Lake Victoria, Torrens, Gregory, Gairdner, Blanche,	South Australia.

LARGEST LAKES.

LAKE.	Area in Sq. Miles.	LAKE.	Area in Sq. Miles
Ladoga,	6,330	Superior,	32,000
Onega,	3,400	Huron,	24,000
Wener,	2,000	Michigan,	20,000
		Erie,	9,600
Caspian Sea,	140,000	Ontario,	6,300
Aral,	26,000	Great Bear Lake,	19,000
Baikal,	14,800	Great Slave Lake,	12,000
Balkash,	7,000	Winnipeg,	9,000
Victoria N'yanza,	53,000	Maracaybo,	5,000
Albert N'yanza,	?	Dos Patos,	5,000
Tanganyika,	?	Titicaca,	3,800
Tchad,	15,000		

EXERCISES.

1. Point out the great water-shed of Europe, and those of the other continents. Which is the highest water-shed in the world? and what rivers rise there? Name the great slopes and river-systems of each of the continents, and the longest and shortest slopes of each. What mountains bound the chief river-systems? Which systems belong partially to two slopes? Name all the rivers that rise in the same mountains. Which rivers of different systems rise nearest each other in each of the continents? Which mountain-system gives rise to no large river? Which mountains in Africa and North America are crossed by rivers? Which two African rivers rise in the same lake? Which continent is remarkable for binary rivers? Point them out. Which slope of South America has no large rivers? Name the continental rivers of Europe, Africa, and South America. Give regions of elevation and regions of depression in which continental basins occur. Name the largest rivers that have a westerly course. Name rivers that have deltas, and those that have estuaries. Classify the rivers according to their ocean basins. Which ocean receives none? In what regions are there fewest rivers? and why?

2. Which rivers form boundaries of countries? which of continents? Name the chief inter-tropical rivers. By what characteristics are they distinguished? Name all the large rivers of the Southern Hemisphere. Name smaller rivers in each of the river-systems. Name the principal tributaries of the Rhine, Danube,

Ganges, Nile, Mississippi, Amazon, etc. How could you pass overland entirely, or most nearly so, by water from the Baltic to the Black Sea?—from the Arctic Ocean to the Gulf of Mexico?—from the mouth of the Orinoco to the Rio de la Plata?—from the West Coast of Africa to the East Coast? Arrange the rivers in the order of length, and compare them with that of the Thames and of each other. Give a comparative view of them by means of a scale or otherwise. Measure on the map the direct distance from source to mouth of the Volga, Vistula, Rhine, etc., and compare it with the absolute length. Arrange the largest river-basins in the order of size, and compare them with the area of Great Britain or of the Thames basin (6160 square miles.) Draw a map of each continent showing the River Systems.

3. Which is the largest fresh-water lake in each of the continents? Which is the largest salt lake in the world? Which lakes are on the frontiers of countries? Name the mountain systems or river basins with which the lakes in the Table of Lakes are severally associated. Name those situated in plains. What rivers do they receive or give out? Into what seas do they discharge? Which lakes of Europe, Africa, and South America are continental? Which continent has fewest lakes? Which continent has only comparatively small ones? What is the height above sea-level of Lake Titicaca? Compare the areas of the largest lakes with that of Loch Lomond, the largest British lake (45 square miles), and with each other. Draw a Map showing the Lake Systems.

CHAPTER VI.

THE ATMOSPHERE.

Characteristics of the Atmosphere—Composition of Air—The Atmosphere and Light—Winds—Constant Winds—Periodical Winds—Variable Winds—Storms—Local Winds—Calms—Climate—Temperature—Snow-line—Continental and Maritime Climates—Distribution of Heat—Moisture—Evaporation — Dew — Fogs — Clouds—Rains — Periodical Rains—Variable Rains—Constant Rains—Rainless Regions—Snow—Avalanches — Glaciers — Icebergs — Hail — Influence of Climate on Health—Causes Affecting Climate.

48. Characteristics of the Atmosphere.—The waters of the ocean are only a partial covering for the body of

the earth: the atmosphere is another great ocean, but of a different fluid, which envelops, as an outer covering, both sea and land, and partakes of all the motions of the globe itself. It is supposed to extend to a height of 45 or 50 miles; and, its pressure at the sea-level being equal to nearly 15 lbs. on the square inch, the weight of the whole engirdling mass has been estimated at 5 quadrillions, 295 trillions, 900 billions of tons.

But the air, as this atmosphere is called, is highly elastic, and becomes less and less dense as it recedes from the earth's surface. At the sea-level it balances a column of mercury nearly 30 inches high, or a column of water 35 feet in height; but at a height of about 12,000 feet, equal to the higher summits of the Alps, it is only half the density; and at twice that height, equal to the highest summit of the Andes or the higher Himalayas, it is only one-fourth, and its pressure varies to the same extent. Hence the difficulty of breathing, and the bursting of blood from nose, eyes, and ears, from want of sufficient external pressure on the frame, and the giddiness and fainting experienced by the Alpine traveller. But although at 45 or 50 miles the air will be of inappreciable tenuity, it is every way probable that an atmosphere, distinct from the ether which occupies all space, still exists, and acts upon meteors and other light-giving bodies at 210 miles above the sea-level. The pressure is measured by an instrument called a barometer, and the temperature by a thermometer; and these instruments vary with so much regularity, according to elevation, that they are used for determining the heights of mountains, the mercury in the barometer falling 1° for every 800 feet of rise, and the boiling-point of water falling 1° for every 300 feet.

49. Composition of Air.—Air, pure and dry, consists chiefly of two gases mixed together, but not chemically combined, in the proportion of about 79 parts of nitrogen to 21 of oxygen in volume (or about 4 to 1), but 77 of the former and 23 of the latter by weight. With these

are mixed very minute quantities of carbonic acid and carburetted hydrogen, with a trace of ammonia; and it is never free of watery vapour, in greater or less quantity, according to the temperature. This last ingredient, however, forms no essential portion of the air.

50. The Atmosphere and Light.—The air is the great medium of light. If the rays fall vertically, only 8000 out of 10,000 reach the earth's surface, and the greater the angle of inclination the greater the number absorbed, till, when the sun is horizontal, only five rays out of 10,000 reach the eye of the spectator. Hence the ease with which we can gaze on the rising or the setting sun. Vapour, whether in the atmosphere or in the sea in the form of water, absorbs all the coloured rays of light except blue, which may serve to account for the blueness of the sky and of the ocean; for, when above the vaporous region of the atmosphere, as in deserts or at the tops of high mountains, the sky appears almost black. But light is not only *absorbed;* it is also *reflected*, *refracted*, and *dispersed*. Hence the rays are scattered and bent over the earth, so as to illumine a greater surface than they otherwise would; and thus valleys and surfaces not directly exposed to the sun are lighted. Without this, "shadows would be as black as night, deep valleys would be always buried in darkness." To the sun's refraction we owe that grateful dim light called *twilight*, for refraction takes place till the sun is from 15° to 20° beneath the horizon. Within the tropics the sun sets almost perpendicularly, and therefore speedily; but in higher latitudes he sets more slantingly, and therefore more leisurely. Hence in the former there is next to no twilight; but in the latter, where it is most needed, it is long and grateful. To the same causes are due the *mirage*, by which pellucid lakes appear in the burning desert, with islets and groves of delicious verdure rising from their bosom; the *rainbow*, with its resplendent arch and gorgeous tints, along with *halos*, *mock-suns*, *the fata morgana*, and other optical illusions.

WIND & RAIN CHART.

J. Bartholomew, Edin.

But air is also the great medium of heat and moisture, elements which will be discussed hereafter, and therefore the most important agent in the production of climate. At the same time, it is itself the indispensable aliment of fire, and of all animal and vegetable life.

WINDS.

51. As there are currents in the ocean, so there are currents in the atmosphere, called **winds**; and they owe their existence chiefly to the same cause, viz., the inequality of temperature or density of different portions of its mass. Whenever any portion is heated, it expands, loses its specific gravity, and ascends; and the colder air from adjacent parts being heavier, rushes in to supply the vacancy and restore equilibrium. This colder air, forms an under or surface current, and the rarefied air in the higher regions of the atmosphere to which it has ascended, moves off, as an upper current, in a contrary direction. Different strata of the air, indeed, are often moving in opposite courses; and from the existence of one current, we may generally infer the existence of a counter-current in a different region of the atmosphere. These currents may vary in velocity from the gentlest zephyrs to the most violent hurricane. A speed of 7 miles an hour is regarded as a gentle air, of 14 as a light breeze, of 21 as a good sailing breeze, of 41 a gale, of 61 a great storm, of 82 a tempest, and 92 a hurricane producing universal devastation.

Classification of Winds.—Winds are of three kinds, viz., **Constant, Periodical,** and **Variable.**

1. **Constant Winds.**—The most remarkable of these are the **Trade-Winds** and the **Polar Winds.**

(1) The **Trade-Winds** (so named from their favourable influence upon *trade* or commerce, as affected by navigation), prevail within the Torrid Zone and a few degrees beyond it. This zone being the most highly heated, the rarefied air ascends, and flows off north and south as

upper currents; and the cool air from regions north and south rushes in as under-currents, to preserve the equilibrium. There are thus established two sets of air-currents or winds—two warm, light north and south upper currents, and two cold north and south surface currents. And, but for the earth's rotation, there would be a constant north wind at the surface in the Northern Hemisphere, and a constant south wind at the surface of the Southern Hemisphere. But these north and south winds cannot partake all at once of the more rapid rotation of surface towards the Equator, and are diverted to the west, and thus become north-east and south-east winds respectively. Their limits are not altogether stationary—advancing farthest to the north in the northern summer, and farthest south in our winter. The trade-winds of the Atlantic and Pacific are steady and perennial, blowing at a speed of 10 to 20 miles an hour; but owing to the inequalities of surface and temperature of the land, they are modified into periodical winds as they approach the continents. Hence they are experienced only over the oceans, and never within about 100 miles of land.

(2) **Polar Winds** are constantly blowing within the Polar regions, north and south from either Pole. But these winds, after leaving the regions of their birth and proceeding towards the equator, are modified, as already explained, into trade-winds.

2. **Periodical Winds.**—(1) **Monsoons.** The most important of the periodical winds are the Monsoons, or "season winds," because they change their course with the seasons—blowing from one quarter for one half the year, and from the opposite quarter for the other half. They prevail chiefly in the northern part of the Indian Ocean. They are but the trade-winds modified in their course by the configuration and relative position of the regions which they traverse. From April to October, the **south-west monsoon** prevails north of the Equator, caused by the great rarefaction of Southern Asia in the northern summer. From October to April, the **north-east monsoon**

prevails, caused by the greater rarefaction of Africa during the southern summer. South of the Equator, the **north-west monsoon** blows from October to April, and the **south-east monsoon** from April to October. The shifting of these winds, which is termed "the breaking of the monsoon," is always attended with violent storms of thunder and lightning.

(2) **Land and Sea Breezes.**—These prevail on almost every sea-board, but most notably in tropical countries, where they occur with great persistency and regularity. The **land-breeze** sets in during the night, the **sea-breeze** during the day. These phenomena depend upon the unequal temperature of sea and land by night and by day. In some localities these breezes are limited to a few miles from the shore, while in others they extend over many leagues—wafting fragrance to the passing voyager from the spicy groves of Ceylon, or the perfumed shores of "Araby the Blest."

3. **Variable Winds.**—With the exception of the Trades, the Polar Winds, the Monsoons, and Land and Sea Breezes, winds are more or less variable, indeed proverbially changeful. But they are not less obedient to law, although less understood from being partial in their causes and operations. Less persistent than the trades are the south-west winds of the higher latitudes of the Northern Hemisphere, and the north-west winds of corresponding latitudes of the Southern Hemisphere. These may be considered the prevailing winds of these regions. As the warm currents from the Tropics proceed north and south, they are gradually cooled and condensed, and therefore descend; but as they still preserve a portion of the momentum acquired from the rapid rotation of the Equatorial regions, they are deflected eastwards, and thus become respectively south-west and north-west winds.

"The average packet voyage from New York to Liverpool is twenty-three days, but the return voyage forty days; and westerly winds are three times more frequent at Cape Horn than easterly ones."

"In all latitudes between the parallel of 30° or 35° N. and 30° or 35° S., the prevailing direction of the wind is from the eastward; in all other parts of the world, except the monsoon regions, as far as observation has gone, it is from the westward."—*Maury's Physical Geography.*

Within the Tropics an upper west wind is constantly flowing as a return current to the trades. Dust from West Indian volcanoes has fallen on ship-board hundreds of miles to the east; and at the summit of Teneriffe, a south-west wind in summer prevails, while the trade-wind below is blowing from the north-east.

52. Storms.—Storms are winds blowing with great force and velocity, and they may vary from a strong gale at 41 miles an hour to a hurricane of 92, or even 100 miles. They may blow for a considerable time over the same area, and from the same general direction, and are sometimes accompanied with thunder and lightning. But the most remarkable and destructive storms have a spiral or whirling motion; they twist round an axis with extreme rapidity, and at the same time move forward, sometimes in a straight line, but most generally in a curve. They are confined to certain areas, blow only for a short time in the same place, and are continually and rapidly changing their direction. They are known as **Tornadoes, Typhoons,** and **Cyclones,** in different regions, but they are all regarded as cyclonic in character. They are most violent within the Tropics, more particularly on the borders of the Tropics and the Temperate Zones. But there are three well ascertained regions of these storms, viz., the West Indies, the Indian Ocean, and the China Seas.

(1) **Hurricanes,** or **Tornadoes,** owe their violence and velocity to electrical influences, and are accompanied in general with thunder and lightning and torrents of rain. They are most frequent in the West Indies, about the time of the Equinoxes, and in the Indian Ocean at the change of the monsoons.

(2) **Typhoons** visit the Chinese seas about once in three years, and generally from June to November.

(3) **Cyclones** occur most frequently between the Equator and the Tropics, and near the Calms of Cancer and Capricorn. They sweep round and round, at the same time moving forward in a curve, varying from 100 to 1000 miles in diameter. They travel obliquely from the Equator to the Poles, and over a tract of 3000 miles—in the Northern Hemisphere from right to left, in the Southern Hemisphere from left to right.

(4) **Whirlwinds** are most frequently caused by the meeting of contrary winds, and assume a rotatory or whirling motion. They cause water-spouts at sea, and sand-pillars in the desert.

Local Winds.—The characteristics and influence of these vary greatly with locality.

(1) **Hot Winds.**—The most noticeable are those noxious winds that originate in the great desert of Sahara in North Africa. Their general name is the **Simoom** (Arabic for *hot, poisonous*); but in Turkey they

THE SIMOOM.

are called **Samiel**; in Egypt, **Khamsin**, *(fifty*, because they continue fifty days); in Guinea and Senegambia, **Harmattan**; in Italy the **Sirocco**: and in Spain, the **Solano**.

The **Simoom** is a hot, suffocating blast, laden with excessively fine particles of sand, which often give a reddish colour to the atmosphere, and thus afford forewarning of its approach. It withers vegetation, and often fatally affects animal life; the caravan not unfrequently sinks beneath the thirst and fever it engenders, and leaves the bones of the traveller to whiten amid the sands of the desert. To escape its baneful effects, it is necessary to lie prostrate on the ground with face buried in the sand till the violence of the blast has abated.

The **Föhn** is a hot wind that blows occasionally over Switzerland.

(2) **Cold Winds.**—On the other hand, the plateau of Peru, 12,000 feet above the sea, is swept for four months of the year by piercingly cold winds from the snow-clad Cordilleras, so extremely dry as to prevent putrefaction of animal remains. These are known as the **Puna Winds**, from the upland of the Puna, where they originate.

The **Pampero** is a violent west wind which traverses the pampas of Buenos Ayres, withering vegetation from its extreme dryness, and obscuring the air with whirlwinds of dust, which it carries forward to the Atlantic. It is a portion of the north-west trade-winds which have crossed the Andes, just as the Puna winds are a portion of the south-east trade-winds.

Other cold winds are the **Bora**, a north-east wind from the Alps in Istria and Dalmatia (at the head of the Adriatic Sea), so violent as sometimes to overturn men and horses at the plough; the **Mistral**, a violent north-west wind in the valley of the Rhone, in the south-east of France; the **Gallego**, a formidable north-west wind in Spain; and the **Vent de Bise**, a north-east wind general over the northern shores of the Mediterranean.

The **Etesian Winds** ("annual" or "seasonal" winds) blow from the north in summer over the Mediterranean, caused by a flow of cool air from the north to replace the highly heated air that rises from the sandy desert of

Sahara in the north of Africa. But they are variously modified at different seasons and in different regions.

Calms.—There are three zones or belts of Calms—viz., the **Equatorial Calms**, the **Calms of Cancer**, and the **Calms of Capricorn.**

These calms are confined to the oceans, and fluctuate with the seasons. The Equatorial belt, which has an average breadth of about six degrees, is not continuous; and it lies generally several degrees to the north of the Equator, separating the two trade-winds, except in the Indian Ocean, where it presents a forked appearance, extending on both sides of the Line. The Equatorial Calms of the Atlantic are termed by seamen the **Doldrums.** But the prevailing calms of these regions, in which vessels are sometimes detained for weeks, are often suddenly broken by terrific storms of thunder and lightning, torrents of rain, and gusts of wind from every point of the compass in the course of a single hour. The Calms of Cancer and Capricorn extend along the latitude of 30° north and south, the extreme limits of the trade-winds. The region of the Calms of Cancer is called by sailors, "the horse-latitudes."

CLIMATE.

53. Under the term **Climate** are included all the combined elements that affect the weather of any district, and the principal of these are **temperature** and **moisture.**

54. Temperature.—Atmospheric temperature is primarily due almost solely to the heat of the sun; and that heat is most intense within the Tropics, where the solar rays are vertical, or nearly so; for the higher the angle at which they strike the earth, the greater is the effect—just as the sun is strongest at noon, when he is most nearly overhead. Hence, within the Torrid Zone the heat imparted by the sun is equal to that received by all the rest of the earth. The heat thus received by the earth being again radiated into the atmosphere, the lower

strata of air will be warmer than the higher—the decrease of temperature being equal to 1° Fahr. for every 300 or 350 feet of altitude. Thus, there are two great causes similarly affecting temperature, viz.:

(1) **Latitude**, or distance from the Equator; and,

(2) **Altitude**, or height above the level of the sea.

It is, therefore, nearly the same whether we proceed from the Equator to the Poles, or ascend vertically into the atmosphere, as, for example, in climbing a lofty mountain. In both cases we reach, at last, the region of perpetual snow, the lower edge of which is called the **snow-line**—at the sea-level at the Poles, at the height of 16,000 feet at the Equator. And in the intermediate spaces, in each case, will be corresponding zones of temperature, and, therefore, of animal and vegetable life—the same phenomena being observable in the ascending areas engirdling a lofty mountain as in traversing the 6000 miles from the Equator to the Poles. At the base of the mountain (if within the Tropics) will be found all the characteristics of the Torrid Zone; midway up those of the Temperate; and at the summit those of the Frigid Zones. In tropical America, Guayaquil on the coast suffers from intense heat all the year round; Quito, 10,000 feet higher, enjoys perpetual spring; and the summits of the neighbouring Andes, 6000 feet higher than Quito, have eternal winter.

Snow-line.—The height of the snow-line varies not only with latitude, but also with the situation as regards exposure to the sun and rain-bearing winds, the degree of humidity of the climate, and other causes, so that no general rule can be laid down. But it is about 4000 feet higher on the north than on the south side of the Himalayas, owing chiefly, on the one hand, to the great dryness of the vast table-lands of Central Asia, which increases the radiation of the solar heat, and therefore the evaporation; and on the other hand, to the moisture conveyed to the southern slope by the warm winds from the Indian Ocean. Thus, millions of men occupy populous

towns in a region which, but for this arrangement, would have been buried under snow the whole year. The snow-line is also higher in the interior of continents than near the coasts, and higher on the east than on the west sides. It is highest, not at the Equator, but near the Tropics, where the summer-heat is greatest—the day being there 13½ hours at the longest, while never more than 12 at the Equator.

None of the British mountains reach the snow-line, but Ben Nevis is supposed to be within 150 feet of it; and the proprietor of Ben Wyvis once held his land on condition that he presented to the superior a snow-ball from the mountain whenever required.

HEIGHT OF SNOW-LINE IN DIFFERENT LATITUDES.

	N. Lat.	Height in Feet.		N. Lat.	Height in Feet.
Spitzbergen,	78°	0	North Himalayas,	29°	19,560
North Cape,	71°	2,400	South Himalayas,	28°	15,500
Sulitelma (Norway),	67°	3,835	Abyssinian Mts.,	13°	14,065
Kamstchatka,	56½°	5,249	Puracé (Andes),	2½°	15,381
Oonalaska (Aleutian Isles),	53½°	3,510		S. Lat.	
Altai,	50°	7,034	Andes of Quito,	0°	15,820
Alps,	46°	8,885	,, Bolivia,	16°	17,717
Caucasus,	43°	11,063	,, ,,	18°	20,079
Pyrenees,	42½°	8,950	,, Chili,	33°	14,730
Rocky Mountains,	43°	12,467	,, ,,	42½°	6,010
Mount Etna,	37½°	9,500	Straits of Magellan,	53½°	3,707
Sierra Nevada (Spain),	37°	11,200	South Georgia,	54½°	0

55. Continental and Maritime Climates.—The ocean, radiating its warmth much more slowly than the land, and its area being three times greater, it becomes a vast storehouse of heat, which (independently of evaporation) its waves, tides, and currents distribute over the globe. By these, as well as by winds, it tends to equalize the temperature of the land; hence islands and seaboards possess a more equable climate than the interior of continents—less cold in winter, and less hot in summer. The British Isles are thus said to possess a **maritime** or **insular climate**, the interior of Germany and Russia a **continental climate**. Hence, also, the greater extension of land in the Northern Hemisphere confers upon it a

continental climate: the greater expanse of ocean in the Southern imparting more of a maritime climate. For the same reason, the **snow-limit*** in the Southern Hemisphere is 10° nearer the Pole than in the Northern; in the latter being nearly coincident with the parallel of 30°, in the former, with that of 40°.

London, nearly 2° north of Paris, can rear plants in the open air which must be sheltered in the green-houses of Paris; the Shetland Isles, 10° still farther north, have a winter temperature higher than that of Paris, and equal to that of London; the myrtle flourishes as well in the north of Ireland as in Portugal; and the northern shores of the Black Sea are frozen in winter, while those of the British Isles are perfectly clear of ice.

56. Distribution of Heat.—The Torrid Zone has not only the highest temperature, but it has little variation of temperature throughout the year, the sun being vertical, or nearly so, all the year round, and there being little difference in the length of day and night. The Temperate Zones are distinguished for their regular succession of climatic changes, which determine the four seasons, Spring, Summer, Autumn, and Winter, with great differences of temperature. The Frigid Zones have only two seasons—one long winter of extreme cold, and a short summer of great heat. Chiefly from the unequal distribution of land and water and difference of elevation, the heat does not decrease everywhere at equal pace with the increase of latitude. The Southern Hemisphere decreases in temperature with latitude much more rapidly than the Northern, and is, on the average, $3\frac{1}{2}°$ colder. The Warmth Equator is not coincident with the Geographical Equator, but runs irregularly, for the most part, a little to the north of it, and its mean temperature is 80°.

In the same way, lines of equal heat (called **isotherms**) are irregular wavy lines, and by no means parallel to each other or to the parallels of latitude. Thus the isotherm

* The **snow-limit** is the line on the equatorial side of which snow never falls at the level of the sea.

of 30°, that is, of constantly frozen ground, in the Northern Hemisphere, passes through the south of Hudson's Bay, south point of Greenland, to the north of North Cape, through the White Sea, Lake Baikal, and Kamtchatka.

The temperature diminishes more rapidly northwards in North America and Eastern Asia than in Europe. In the Northern Hemisphere the western coasts are warm, and the eastern cold; in the Southern Hemisphere the eastern are warm, and the western cold. This is due to the ocean currents and winds, already described. The coldest region in the world is in Siberia, stretching from the north of Lake Baikal north-eastwards into the Northern Ocean, in the form of a long ellipse. At Yakutsk, on Lake Baikal, the ground is frozen to a depth of 382 feet. The hottest region of the globe is on both sides of the Red Sea—from the Sahara through Nubia and the middle of Arabia to the Persian Gulf. The mean temperature of the North Pole is 2°, of the Equator, 80°, and of the whole earth, 58°.

MOISTURE.

57. Evaporation.—Moisture is always present in the atmosphere in the form of invisible vapour; and the warmer the air, the greater is its capacity for moisture. This moisture is supplied by evaporation from the surface of land and water; especially the latter, and on account of its larger area, mainly from the ocean. This evaporation, depending, as it does, upon the solar heat, is greatest in the Torrid Zone, where it is estimated that 16 feet in average depth of water are raised in a year from the surface of the sea. The force for making and lifting vapour from an area of one acre is equal to 30 horse-power, and for the whole area of the earth 800 times greater than all the water-power of Europe. The whole of this mighty mass of water is again precipitated upon the earth as dew, rain, snow, or hail.

58. Dew.—Dew is one of the results of the condensa-

tion of vapour. After a warm day, when the earth has been heated by the sun, and when evening sets in, the surface loses its caloric or heat by radiation into the atmosphere. It is only good radiators, however, that do so, such as grass, glass, painted wood, etc., whereas metal, sand, gravel, rock, etc., which are bad radiators, do not. These radiating bodies become cooled, and so does the air immediately in contact with them. This air can no longer retain the same amount of moisture, and deposits a portion upon the radiating surfaces in the bright glittering globules called dew. The degree of temperature required to produce this deposition is called the *dew-point;* and if the atmosphere has been well saturated by the previous day's heat, only a slight depression of temperature is required. Hence, in tropical countries, the deposition of dew is most copious, and largely compensates for the absence of rain by its refreshing and cooling moisture. And, by a wise provision, it is only grass and plants that require it most that are thus supplied, for the gravel and rock receive none. Besides a *warm day preceding* to provide vapour in the atmosphere, the air must be *clear* to permit a free radiation, and *calm* to allow the cooled air to remain in contact with the radiator; and no tree or other object, not even a cobweb, must overshadow the radiating body, else radiation is effectually intercepted. At two or three inches above, the chilling is diminished to one-half, and at six feet to one-twentieth—the body itself being generally 4° lower than the surrounding air. The air, by continually parting with its caloric, may fall below the freezing point, and the moisture may be deposited in the form of **hoar-frost**, which is just frozen dew.

59. **Fogs.**—**Fog** or **mist** is formed by currents of moist air coming in contact with the colder surface of the earth, and condensing the contained moisture into the visible form of fog or mist. Mountain sides, river valleys, the sea-coast, and cold countries are favourable to the formation of fogs; and it is the vapour produced from the warm waters of the Gulf Stream, condensed

by the cold of the Arctic Current and the northern icebergs, that gives rise to the dense fogs of Newfoundland.

60. **Clouds.**—If instead of being condensed near the earth, as in the case of fogs and mists, the vapour is condensed at some considerable elevation, the result is a cloud. It remains for a longer or shorter period suspended in the air motionless, but most frequently moved by the winds; but why it does not, when thus condensed, immediately fall to the ground, has not been satisfactorily explained. Some clouds indeed remain stationary, attached to a mountain summit, as at Mount Pilate in Switzerland, Table Mountain at Cape of Good Hope, and elsewhere, where the cloud is the condensation formed by the cold mountain side; and as fast as a portion is drifted away by the wind, another is formed, which gives the cloud an appearance of permanence. But the clouds are generally in motion, different strata of them indeed often moving in different directions at the same time. Their rate of motion is not unfrequently from 70 to 100 miles an hour, although, from their great height, their apparent speed is much less. The cloud region of this country is from 2000 to 6500 feet high, with a thickness of 2000 to 3000 feet; but in the trade-wind region, it ranges from 3000 to 5000, where also the cloud-region is higher over sea than over land, whereas in other regions it is the reverse —higher over land than over sea, and the higher, too, the further inland.

Classification of Clouds.—Clouds are grouped into seven classes—three primary, and four secondary or compound forms, viz.:—

Primary.—(1) **Cirrus**, or Curl Cloud; (2) **Cumulus**, or Summer Cloud; (3) **Stratus**, or Fall Cloud.

Compound.—(4) **Cirro-cumulus**; (5) **Cirro-stratus**; (6) **Cumulo-stratus**; and (7) **Nimbus**, or Rain Cloud.

(1) The **Cirrus**, or **Curl Cloud**, is the name applied to light fleecy clouds, and is so named from the beautiful curl their parts assume. Curl clouds are the highest of all clouds, being not less than three miles in height, and

often five or six. They are therefore the lightest clouds, and are supposed to consist of minute ice-crystals, or very fine snow-flakes. They arrange themselves in parallel or divergent bands, arranged at the Equator nearly from north to south, but in this country from north-west to

CIRRUS.

south-east. They form what are known as "mackerel-skies," and it is amongst them that halos and mock-suns are visible. When they appear after a day of north wind, it is a sure sign of approaching wet and stormy weather. They are supposed to be the heads of columns of vapour precipitated so soon as they reach a certain elevation.

CUMULUS.

(2) The **Cumulus**, or **Summer Cloud**, is the massy

fleecy cloud of the lower and middle sky, arranged in rounded and fantastic shapes, and often presenting the appearance of a range of snowy mountains. It is formed after sunrise, gradually increases, and rises higher as the day advances, being carried upwards by the ascending columns of heated air, but disappears towards evening as the ascending column gives way to a descending column, when the temperature falls. Fleecy outriders from its sides betoken speedy rain.

(3) The **Stratus,** or **Fall Cloud,** is the heavy bank or layer of vapour or cloud, which rests upon the horizon, which is formed at night-*fall* (hence the name), and

STRATUS.

which vanishes on the approach of day. It is the cloud of the night, as the cumulus is that of the day. Closely allied with it are mists and fogs, and it is formed in the same way, viz., the condensation of the vapour of low river-flats and valleys. If not dissipated by the morning warmth, it may become permanent, and pass into rain cloud.

(4, 5, and 6) The **Cirro-cumulus, Cirro-stratus,** and **Cumulo-stratus** are but combinations of two of these simple forms, and need not here be described.

(7) The **Nimbus,** or **Rain Cloud,** called also **Cumulo-cirro-stratus,** presents a leaden grey appearance, and, when discharging rain, a ragged and frayed under-surface.

It is generally low, from 1000 to 5000 feet, and is formed by the cumulus drifting under the cirro-stratus, whence is formed the true rain cloud, with its mass of saturated vapour.

RAINS.

61. The annual precipitation of rain would, on an average, cover the globe to the depth of five feet. This would give 186,247 cubic miles of water, or 760 billions of tons for the total annual rainfall over the globe. And to hoist all this mass high into the air, to transport it over the globe, and deposit it again at the right places, at the right times, and in due proportion, is the province of the winds. They are the machinery employed to work the grand water-system of the globe.

Distribution of Rain.—Moist warm air is like a wet sponge. A cold air meeting it condenses its moisture into clouds (or visible vapour), and still further into heavy drops which fall as rain, just as the pressure of the hand squeezes the water from the sponge. The winds commingling the cold and warm strata of air, rain will be most frequent where the winds are most variable, that is, in the Temperate Zones, and least frequent where the winds are constant and of equal temperature, that is, in the Torrid Zone. But from the greater evaporation, and the greater capacity for moisture of the heated air in inter-tropical regions, the rains are there most abundant, and they decrease in quantity as we advance into higher latitudes. From the island of Hayti in the West Indies to Finland in the north-west of Russia, the decrease ranges from 150 to 13 inches. But though the rainfall of the Tropics is the most abundant, the number of rainy days is fewer than in high latitudes—being in the latter distributed irregularly over the whole year. Thus, at the Equator, the whole rainfall of 95 inches is confined to 78 or 80 days; but at St. Petersburg the fall of 17 inches is distributed over 169 days.

The trade-winds are the great evaporators; and as the south-east trades blow over three times as much water as the north-east ones, the rains they convey to the Northern Hemisphere are half as much again as those in the Southern Hemisphere: a providential arrangement for the watering and fertilizing of the land of the globe, which lies so largely on its northern side. In the North Temperate Zone the mean annual rainfall is 37 inches; in the South Temperate, 26 inches. The rainfall is always greater near the coast than in inland regions—the air losing its humidity by degrees, as it passes into the interior. From the moist and verdant Ireland eastwards to the rainless Desert of Gobi in Central Asia, we find an almost regular gradation from the extreme of humidity to that of drought.

	Rainy days per annum.		Rainy days per annum.
East of Ireland, . . .	208	Basin of the Volga, .	90
Netherlands. . . .	170	Interior of Siberia, .	60
England, France, N. Germany,	155	Desert of Gobi, . .	0

Mountains are the great condensers of moisture. Their cold summits arrest the passing vapour, and transform it into clouds, which hang about their summits till they descend in rain, and pour in numerous torrents down their sides. Thus every mountain-system becomes the centre of a system of irrigation to the surrounding regions; and rugged mountainous countries, like Scotland and Switzerland, are the wettest. The side of a chain exposed to the moist wind receives a much larger share than the opposite. Thus, the Scandinavian Alps, with their lofty frozen heights, condense the moisture of the south-west winds from the Atlantic, and cause a precipitation on their Norwegian side about four times greater than that in Sweden, on their eastern side. The same wind may carry rain to one side of a mountain, and clear cold weather to the other; and thus mountains may not only separate countries, but climates. For a similar reason lofty plateaux are dry—the winds being robbed of

their moisture on their way up the ascending slopes. Thus, Madrid, in the centre of the plateau of Spain, receives only 10 inches of rain; being at least 100 less than the west coast of Portugal in the same latitude.

Classification of Rains.—Rains being so closely dependent upon winds, are, like them, divided into **Periodical, Variable,** and **Constant,** whilst in some regions they are altogether absent.

(1) **Periodical Rains.**—The Periodical Rains occur within the Tropics, where the year is divided into two seasons—"the rainy" and "the dry." The rains follow the apparent course of the sun, prevailing north or south of the Equator according as the sun is vertical in these regions. In general terms, the rainy season may be said to extend, on the north of the Equator, from April to October, and the dry from October to April, and the reverse of this to characterise the south side of the Equator. The periodicity, however, depends greatly upon distance from the Equator, the configuration of the land, and similar causes; but in the same localities the rains recur with the greatest regularity. From 5° to 10° north and south of the Equator, two rainy seasons and two dry ones occur annually, because the sun crosses the Equator twice in the year. The rains, although very heavy, are not continuous during the wet season; they never fall at night, and during the day only from noon till 4 or 5 o'clock, when it pours in torrents. During the dry season no rain falls for months—the want of rain being compensated for by copious nightly dews. India and other countries around the Indian Ocean have their seasons regulated, not by the course of the sun, but by the monsoons. The south-west monsoon waters the west coast of India, and the north-east monsoon the east coast; for the Ghauts on either side of the peninsula abstract the moisture from the respective winds which they face, and render them dry and rainless to the land on the opposite side.

(2) **Variable Rains.**—Variable rains are extra-tropical. They occur throughout the whole year in the Temperate

Zones; but, on the whole, north of the Tropics, most abundantly in winter. England has eight times more rain in winter than in summer. The countries around the Mediterranean, speaking generally, are regions of winter rains; those of Western Europe of autumn rains; east of the latter (keeping north of the Alps and Carpathians), onwards to the interior of Siberia, is the province of summer rains. The south-west winds of Europe are laden with moisture from the Atlantic (or Mediterranean), while the north-east winds, overland from high latitudes, are cold and dry. But in North America north-east winds bring storms of rain in spring and autumn. In both Temperate Zones the western coasts are the moister, from their exposure to westerly winds from the ocean; but in the Torrid Zone, the eastern are the moister, from their exposure to the trade-winds.

(3) **Constant Rains.**—Whilst in the region of the trades at sea there is scarcely a drop of rain, in the Zone of Equatorial Calms and Variable Winds there is almost constant precipitation, accompanied with frequent thunder-storms of great violence. The rain is there so abundant that the fresh rain-water has been skimmed from the surface of the sea. A portion of this belt, near the Cape Verde Islands, is known to sailors as "the rainy sea." The countries remarkable for their heavy and continuous rains in the New World, are Brazil, Guiana, West Indies, Central America, and shores of the Gulf of Mexico; and in the Old World, Guinea, Senegambia, Eastern Africa, India, and the Eastern Archipelago. The greatest rainfall recorded was in the Khasia Mountains in Bengal—viz., 600 inches per annum, and sometimes 30 inches fall in twenty-four hours.

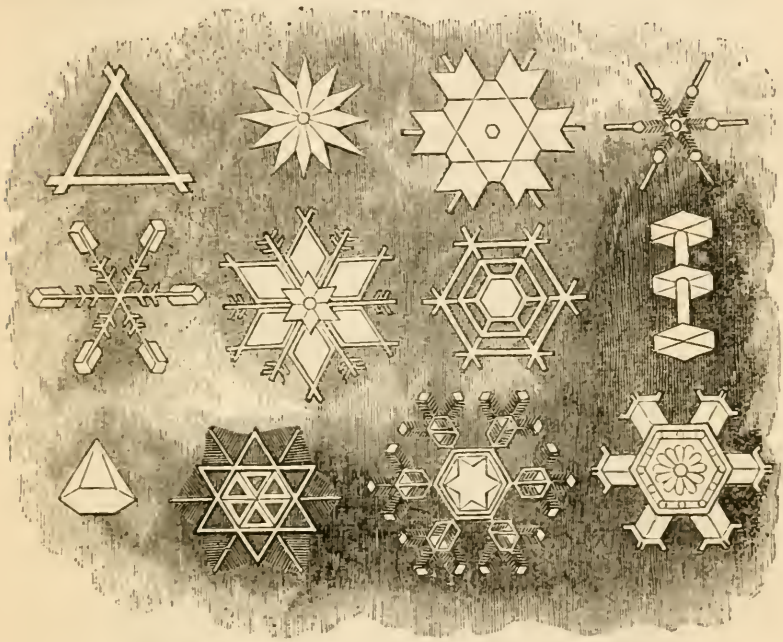
Rainless Regions.—In the Northern Hemisphere are immense tracts of land destitute of rain, forming a belt around the globe along or near the Northern Tropic, and interrupted only by mountain-ranges at one point, viz., at the junction of the Himalayas and Hindoo Koosh. It comprises, in the New World, the plateau of Mexico,

with parts of Guatimala and California; and in the Old World, the Desert of Sahara, Egypt, Arabia, Persia, Beloochistan, the Desert of Shamo or Gobi, and the table-land of Tibet and Mongolia. They measure in all $5\frac{1}{2}$ million square miles. South of the Equator the only rainless district is the Desert of Atacama, a narrow strip of coast, several hundred miles in length, in Peru and Bolivia, crossed at right angles by the Southern Tropic. In some of these regions a drop of rain never falls, whilst in others it falls only at long intervals and in small quantities. A fall of rain (twice or thrice in a century perhaps) is long remembered as a remarkable event. On the Peruvian coast, the rains, driven by the trades, are intercepted by the Andes; in the Sahara, the heated air, from its immense sandy area, cannot condense, but rather dissipates the vapour of winds blowing into it; the other districts are chiefly plateaux, from which the moisture has been intercepted by the acclivities leading up to them, or the heights which wall them in, or are, besides, situated in the range of a dry north-east wind.

SNOW.

62. Snow is the frozen moisture which falls when the atmosphere near the surface of the earth is near or below 32°, the freezing point of water. It is composed of crystals, generally in the form of six-pointed stars, of which about 1000 kinds have been observed, and reduced to five principal varieties. They are often of rare and exquisite beauty, and those of the same fall of snow are generally similar to each other; but this symmetry of form is only to be seen in perfection in high latitudes. Within the snow-limit (about 30° North Latitude and 40° South Latitude) snow at the sea-level is entirely unknown; elsewhere it falls only during winter; and it increases in frequency and amount as we advance into higher latitudes or to greater elevations. It contains ten times its bulk of air, and being therefore a bad conductor of heat, forms

an admirable covering for the earth, protecting vegetation from the severity of frosts, and preventing a too free radiation from the soil. Hence it frequently happens that, in seasons of extreme cold, the soil is 40° warmer than the surface of the snow above it. It is in high latitudes that the value of the "snow-blanket" is most felt and appreciated.



SNOW CRYSTALS.

Phenomena of Snow.—From the long-continued accumulations of snow, partially thawed and compressed on the summits of high mountains, originate the various phenomena of **avalanches, glaciers,** and **icebergs.**

(1) **Avalanches** are immense masses of snow, or snow and ice, frequently detached from the steep slopes of snow-clad mountains, such as the Alps, and precipitated into the plains or valleys below. They rush down with fearful rapidity and violence, overwhelming and burying

farm-houses and villages with their inhabitants, corn-fields, vineyards, and plantations.

(2) **Glaciers** are immense masses of ice formed above the snow-line, which collect in the valleys and ravines of high mountains, and move downwards till they come below the snow-line, and sometimes even far down into the cultivated region, when they melt and disappear in a stream of water. They bear much the same relation to the snow-fields above them that icicles do to the snow-covered roof of a house. They have the general appearance of torrents or cataracts suddenly arrested and congealed by intense frost. The ice itself is of a blue-veined structure, due to great pressure; but although rigid in appearance, it is of a semi-fluid or viscous consistency.

GLACIER OF THE ALPS.

These ice-streams move more or less rapidly according to the temperature and moisture,—the maximum rate being thirty inches a-day in summer, and sixteen in winter; and, like rivers, the velocity is greatest at the centre. The glacier, in its progress over abrupt rocks, often splits, forming cracks or clefts of great depth, termed **Crevasses.** It soon becomes laden with loose stones and other debris, termed **Moraines,** collected from the sides of the moun-

tains; and these are at last deposited, as the glacier melts away, at its lower extremity. The mass, from its immense pressure, grooves and grinds smooth the sides of the mountain gorges it traverses. Glaciers are most abundant in the Alps and Himalayas, Norway, and New Zealand, as well as in Polar regions generally; but they occur wherever snowy mountains of sufficient height exist. The snows and glaciers of the Alps are estimated to occupy 1400 square miles, the glaciers numbering 400. Mont Blanc alone has 34 glaciers, covering 95 square miles, its largest being the Mer de Glace ("sea of ice") in the Valley of Chamouni.

(3) **Icebergs** ("ice-mountains") are great masses of the polar ice-fields or glaciers which have protruded themselves into the sea, and been broken off and floated away. The smaller masses are **Ice-floes** ("ice-islands"), drifting on the surface. These bergs are from 40 to more than 250 feet above the surface; but the depth below is at least eight times greater, and they are often several miles in circumference. "They present the appearance of dazzling white chalk cliffs of the most fantastic shapes," and are always grand and awful. Laden with stones and debris, they are transported by winds and currents into warmer latitudes, where they melt away,—bergs from the Arctic Ocean being met with in the Atlantic as far south as the 44th parallel, and from the Antarctic Ocean as far north as the Cape of Good Hope. They spread a sensible degree of cold around them, accompanied with fogs, and are very dangerous to navigation.

(4) **Ice-packs.**—The Polar seas are frozen during the greater portion of the year; and the vast ice-fields, when broken up under the influences of the advancing season, are heaped upon each other and piled into **ice-packs,** which are drifted into warmer temperatures. Vessels have been frozen up and abandoned, and afterwards drifted 1000 miles in the middle of an ice-field 300,000 square miles in extent and 7 feet thick; and a daring navigator in the Antarctic Ocean (Sir James

Ross) had to force his way 1000 miles through such obstructions.

63. **Hail.**—Hail consists of opaque frozen drops of water, but sometimes it is a nucleus of snow coated with ice. It is supposed to be formed in the higher region of the atmosphere, and to be connected in origin with some electrical disturbance of the air, for it falls often during thunderstorms. Hail-stones are usually pear-shaped, and small, but they have been known as large as hens' eggs, and even almost as large as bricks when frozen together in the atmosphere. They prove destructive to crops, and even to buildings and animals, when of more than ordinary severity. Hail is most common in summer, and at or near the hottest part of the day; it occurs in all latitudes, but most frequently near mountains; it is rare in lowland plains within the tropics, but common at several thousand feet of elevation.

Influence of Climate on Health.—"In Tropical countries, the low grounds are covered with water during the rainy season, hence the unhealthy vapours so fatal to Europeans. In the West Indies, the unhealthy season advances with the sun; and along the coasts of the Mediterranean, the mortality is doubled during the hot season from July to October. In Temperate regions, again, as in the British Isles and the greater part of Europe, deaths are most numerous towards the end of winter, and least numerous in the middle of summer; because in these regions cold begins to be the great enemy of the human constitution. Certain forms of disease have a range nearly corresponding with the several zones. Thus, malarial fevers, especially that called the yellow fever, are characteristic of the Torrid Zone; typhoid fevers and consumption, of the Temperate; colds and catarrhs, of the Frigid. The first class extends northwards in the Atlantic to the Bermuda Islands, but their chief seats are in the Gulf of Mexico and Guinea; the last prevail in all places north of the 60th parallel; the second are the climatic diseases of the British Isles."—*Clyde's Geography.*

SUMMARY OF CAUSES AFFECTING CLIMATE.

1. Latitude.
2. Altitude.
3. Proximity to the Sea.
4. Distribution of Land and Water.
5. Mountain Chains.
6. The prevailing Winds.
7. Oceanic Currents.
8. General Inclination or Slope of a District:—North Slope cold; South Slope warm.
9. The Surface of the Land:—Sand and Rock causing heat and drought; Vegetation, coolness and moisture.
10. Cultivation of the Soil:—Tillage giving warmth; Drainage, dryness; Planting, shelter and moisture.

EXERCISES.

1. Verify the estimate given in the text of the weight of air on the surface of the globe. Explain in your own words the formation of winds. State the points of similarity between winds and ocean currents. Which ocean currents are supposed to be caused by winds, and by which winds? Which season should be the most favourable for a voyage from China to the Red Sea? and which for the return voyage? Which winds would a vessel be most likely to meet with on a voyage from London to Canton, and from New York to San-Francisco? Which of them would aid, and which impede its progress? Which winds are cold? which warm? which humid? and which dry? Account for the difference. Which cold winds are opposed to hot ones? Which winds prevail most during spring in Britain? Are they cold or warm? and why? Write out in your own words a descriptive account of the winds. Draw a map of the Winds.

2. Why is it colder at the top than at the bottom of a mountain? Where in the Southern Hemisphere does a sudden fall of the snow-line occur? Contrast the snow-line of the Pyrenees and Caucasus, the Rocky Mountains and the Cordilleras of Chili with each other. Compare the latitude and snow-line of England and South Georgia. Give an instance of the snow-line being higher on the east than on the west side of a continent. Why should the snow-line be higher in the interior of continents than near the coast? On which side of the Alps and Scandinavian Mountains should you expect the snow-line to be highest? and why? Arrange in form of a diagram the height of the snow-line at different latitudes from pole to pole. Give examples of countries with insular climate, and of others with continental climate.

Whether should Edinburgh or Moscow, both in the same latitude, be the colder? and why? Describe the course of the snow-limit. Which continent is entirely beyond it? Which countries have no snowfall at the sea-level? What is the difference of latitude between the north of Ireland and Portugal, and between the Black Sea and Great Britain? Which currents and winds affect the temperature of the eastern and western coasts of the continents?

3. What are the chief agents in the production of rain? Explain their action. Name mountains besides the Scandinavian Alps which intercept the moisture of the prevailing winds. Account, if you can, for the copious nightly dews of India and other tropical countries. At what periods are the wet and dry seasons on the east coast of India? and when on the west? Name the European countries of winter rains, of autumn rains, and of summer rains. Explain how the phenomenon of skimming fresh water from the surface of the sea is possible. Which of the rainless regions are plateaux, and which are not? How do these regions differ in direction in the Old World and the New? How do they correspond in position? Illustrate by a scale, or otherwise, the gradual decrease of rain from the coast into the interior. Which two large rivers have their sources in the glaciers of the Alps? Which currents transport icebergs? Which thaw them? How much farther do icebergs travel from the Antarctic Ocean than from the Arctic? Illustrate the effects of each of the ten leading Causes affecting Climate, giving examples of each. Write out a descriptive account of Rains. Draw a map of the Distribution of Rain.

CHAPTER VI.

STRUCTURE OF THE EARTH.

The Crust of the Earth—Arrangement and Classification of Rocks—Geographical Distribution of Minerals—Central Heat—Volcanoes—Volcanic Phenomena—Distribution of Volcanoes—Classification of Volcanoes — Effects of Volcanoes — The Geysers — Earthquakes — Earthquake Districts — Uses of Volcanic Agency—Coral Formations.

64. The Crust of the Earth.—It is but a very little way that man has been able to penetrate into the depths of the earth. The miner has never reached farther than

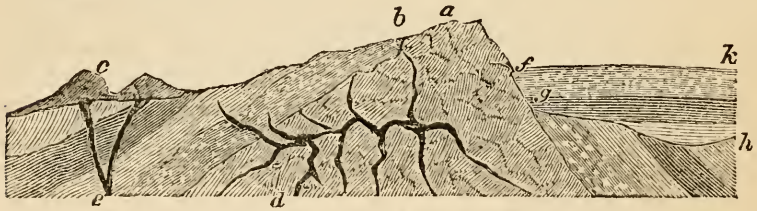
2000 feet below the sea-level, or about the $^1/_{10,000}$ part of the semi-diameter, or distance to the centre of the globe. But by careful observation of the arrangement of the rocks at or near the surface, the geologist has been able to form a tolerably correct estimate of the composition of the earth to the depth of about ten miles.

All the materials of the earth's crust have been the product of either fire or water, and are hence divided into two great classes, **Igneous** rocks and **Aqueous** rocks. The former, such as granite, basalt, and lava, consist of vast, irregular masses, and are therefore termed **Unstratified**; the latter, such as sandstone, limestone, and clay, are arranged in regular layers or strata, and are therefore called **Stratified.** Igneous rocks have been upheaved with tremendous violence by the elastic force of internal heat, breaking through the overlying strata, and are hence termed **Eruptive**; aqueous rocks, deposited from water, like the mud and sands at the bottom of our seas and lakes, and afterwards solidified by enormous pressure, are termed **Sedimentary.** A third kind of rock, such as gneiss and mica slate, called **Metamorphic,** is of aqueous origin, and therefore stratified; and their resemblance to igneous formations is due to the crystallization caused by subterranean fires.

The igneous rocks are the oldest, and at the greatest depth, and are entirely destitute of animal or vegetable remains; the aqueous rocks, the most recently formed, and nearest the surface, abound with organic remains in a petrified state, and are called **Fossiliferous.** Two-thirds of the surface rocks of the earth are fossiliferous; they are often thousands of feet in thickness, and their total depth has been estimated at from seven to eight miles. In the chalk formations whole mountains are formed of shells of microscopic animals, so small that it would require 40,000,000 of them to form a cubic inch. Tripoli, a powder for polishing metals, is largely composed of them.

The stratified rocks would have occupied a position

perfectly horizontal, and overlying the other formations, had not the eruptive rocks burst through their strata, tilting them up at various angles, and taking a position above them. Hence granite, which forms the base of a large portion of the earth's crust, has been upheaved into mountain chains, and even to the very summits of the Alps. But perhaps not more than $^1/_{10}$ of the surface of the dry land is occupied by the unstratified rocks. The metals are of igneous origin; coal belongs to the aqueous formations. The different strata of the earth's crust form great and distinctive epochs in the history of the formation of the globe; and if they are not found invariably present in all parts of the world, they never deviate from an invariable order of succession. Thus, coal is never found above the New Red Sandstone, or below the Old, although strata intermediate in one place may be absent in others.



SECTION OF THE EARTH'S CRUST.

The actual state of the earth's crust will be best understood by a reference to the accompanying illustration. At *a* the igneous rocks are on the surface. The earliest or lowest strata begin to appear at *b*, and the edges of others are passed over in succession as we proceed towards *c*. The same strata occur, with a still greater slope, between *g* and *h*; but here they are covered by later formations (*f*, *k*), whose horizontal position shows that they must have been deposited *after* the forces by which the surrounding rocks were upheaved had ceased to operate. The eminences at *c* are formed of volcanic matter, ejected through the opening seen at *e*; and the dark lines between *b* and *d* represent fissures in the various rocks, produced by earthquakes and similar convulsions, and then filled up, from subterranean treasures, with metallic ores and other substances in a state of fusion. It is from such fissures, usually called veins, that most of the metals and their ores are obtained.

CLASSIFICATION AND ARRANGEMENT OF ROCKS.

SYSTEMS.	CHARACTERISTIC ROCKS.	PERIODS.
	I.—STRATIFIED ROCKS.	
1. Post-Tertiary,	Surface deposits of Sands, Gravels, Peat-mosses, &c., ...	Cainozoic, (Recent Life).
2. Tertiary, . .	Clays, Sands, Gravels, Marls, &c., . . .	
3. Cretaceous, or Chalk,	Chalks, Sandstones, Clays, Shales, . . .	Mesozoic (Middle Life) or Secondary.
4. Oolitic, or Jurassic,	Limestone, Sandstone, Clays, Shales, . .	
5. Triassic, . .	Upper New Red Sandstone, Marls, &c., .	
6. Permian, .	Lower New Red Sandstone, Limestone, &c.,	Palæozoic (Ancient Life), or Primary.
7. Carboniferous,	Coal, Limestone, Ironstone, Fire-clay, Sandstone, &c., ...	
8. Devonian, . .	Old Red Sandstone, ...	
9. Silurian, . .	Slates, Schists, and Limestones, . . .	
10. Metamorphic, or Crystalline Strata,	Gneiss, Mica-slate, Schists, Quartz, &c., (Non-Fossiliferous).	Hypozoic, (Beneath Life).
	II.—UNSTRATIFIED ROCKS.	ASSOCIATED WITH
1. Volcanic, .	Lava, Trachyte or Greystone, Pumice, Tufa, Scoriæ, Sulphur, &c., ... *Examples:*—Ætna, Vesuvius, Auvergne Mts.	Tertiary and upper secondary Formations.
2. Trappean, .	Basalt, Greenstone, Felspar, Porphyry, &c., *Examples:*—The Ochil and Sidlaw Hills, .	Secondary and Upper Primary.
3. Granitic, . .	Granite, Syenite, Porphyry, Serpentine, &c., *Examples:*—The Grampian, Cornish, and Wicklow Mountains, ...	Primary and Metamorphic.

65. **Distribution of Minerals.**—The minerals valuable or useful to man are very profusely distributed over the earth, there being few regions entirely destitute of them, and the most useful are the most plentiful. But it frequently happens that the vegetable productions are the poorest where the mineral treasures are the richest, more especially in the regions producing silver, lead, and coal. Metals are generally found associated with mountains—the metalliferous strata having been upheaved along with them, and thus exposed or rendered more accessible to the miner.

Gold has an especial preference for mountain chains which run north and south, such as the Andes, the

Urals, etc.; and it was from this, along with certain geological analogies, that Sir Roderick Murchison predicted the presence of gold in Australia in 1846, five years before its discovery. The New World has been always famous for the richness and variety of its mineral wealth. The riches of Peru and Mexico have been proverbial, and they formed the chief attractions to the Spaniards who conquered and colonized these countries. The gold and silver mines of both North and South America have yielded, according to computation, no less than 1248 millions of pounds sterling in the three centuries succeeding their discovery. California and British Columbia, Australia and New Zealand, are now the chief gold-fields of the world.

Coal and **Iron**, the most useful of mineral products, follow the same order of distribution, and are very widely diffused; but they have been hitherto most worked in the Temperate Zones, especially the North Temperate; and the richest coal and iron mines of Europe lie north of the Alps. Both minerals are very largely developed in Great Britain, which produces more than 100,000,000 tons annually, or more than all the rest of the world; and they form the chief source of the national wealth. But the largest coal-field in the world is in the United States of North America—the largest being in the Appalachian district—and it is 70 times the area of the coal-field of Great Britain.

Copper.—To the north and east of Lake Superior, in North America, is the richest **copper** region in the world; but that metal is most extensively wrought in England and Chili.

Rock-salt is very abundant. Enormous deposits of it extend 600 miles on each side of the Carpathians; and the salt mines of Wieliczka in Poland, are the most famous in the world, and are wrought at a great depth. There is a hill of salt, 500 feet high, near Mont Serrat in Spain; and the island of Ormuz, in the Persian Gulf, is entirely composed

of it. The salt mines of Cheshire, in England, supply all the British Isles with salt.

The **precious stones** are sparingly distributed. Brazil, celebrated for gems as well as the precious metals, produces most of the diamonds of commerce; but Asia is the great storehouse of precious stones—the finest and largest diamonds in the world, forming the crown-jewels of Europe, being from that continent.

GEOGRAPHICAL DISTRIBUTION OF CHIEF MINERAL PRODUCTS.

GOLD.

Europe—Transylvania, Hungary, North-West of Austria, Ural Mountains.
Asia—Ural and Altaï Mountains, Tibet, China, Indo-China, Japan.
Africa—Kong Mountains, East and West Coasts, South Africa, and the interior generally.
America—British Columbia, California, Mexico, Central America.
Oceania—Australia, New Zealand, Borneo.

PLATINUM.

Europe—The Urals, Spain.
America—New Granada, Brazil.

SILVER.

Europe—Hungary, Transylvania, Bohemia, Saxony.
Asia—The Ural and Altaï Mountains, China.
America—Mexico, Peru, Chili, and the Andes generally.

LEAD.

Europe—Great Britain, France, Spain, Austria, Germany.
Asia—Siberia, Armenia, Farther India, China.
America—United States, Canada, California, Mexico, Peru, Chili, etc.
Africa—Algeria (Atlas Mountains).
Australia—South and West.

QUICKSILVER OR MERCURY.

Europe—Austria, Germany (Palatinate), Italy (Tuscany), Spain.
Asia—China, Japan, Ceylon.
America—California, Mexico, and Peru.

COPPER.

Europe—British Isles, Hungary, Russia, Norway and Sweden, etc.
Asia—Siberia, Persia, India, China, Japan.
America—Canada (near Lake Superior), Cuba, Peru, Chili, Brazil.
Africa—Algeria, Basin of Zambesi.
Oceania—East Indies, South Australia.

TIN.

Europe—England (Cornwall), Saxony, Bohemia, France, Spain.
Asia—Siberia, Tenasserim (Malaya), Burmah, Assam, etc.
America—Mexico, Peru, Chili.
Oceania—Island of Banca, Victoria in Australia.

COAL.

Europe—Great Britain, Belgium, France, Russia, Germany, Sweden, etc.
Asia—Asia Minor, Syria, Persia, India, Burmah, China, Japan.
Africa—Zambesi Basin, Natal, Madagascar.
America—United States, New Brunswick, Cape Breton, Nova Scotia, Vancouver's Island, Cuba, New Granada, Chili, Brazil.
Oceania—Australia, Tasmania, New Zealand, Borneo, Labuan.

IRON.

Europe—The same countries that contain coal.
Asia—Siberia, Asia Minor, Persia, India, Japan.
Africa—Algeria, Zambesi Basin, Cape Colony, Natal.
America—United States, Canada, New Brunswick, Nova Scotia, Cape Breton Island, New Granada, Bolivia, Chili, La Plata, Brazil.
Oceania—New South Wales, Victoria, Tasmania, New Zealand, East Indies.

ROCK SALT.

Europe—England, Austrian Poland, Russia, France, Spain.
Asia—Armenia, Syria, North-West India, China, The Urals.
Africa and America—Very generally diffused.

PETROLEUM.

Europe—France, Italy.
Asia—Siberia, Shores of the Caspian, Persia, Burmah, Japan.
North America—United States (Pennsylvania, Virginia, Ohio), Canada.

VOLCANOES & EARTHQUAKES.

The shading indicates the lines & centres of volcanic activity the darker the shading the greater the force & frequency of earthquakes.

Volcanoes thus • *Central Groups thus* ✱

Area of Concussion of Earthquakes with the dates 1755

J. Bartholomew, Edin.

66. **Central Heat.**—As we descend into the bowels of the earth, the temperature is found to increase with the depth, in the ratio of about one degree in every 54 feet. Were the same rate of increase to continue, at less than 30 miles from the surface a degree of heat would be reached sufficient to melt every known rock. Hence it is supposed that the globe was originally a molten mass, which has gradually cooled down; and that beyond that depth (the supposed thickness of the earth's crust) the interior of the earth is an immense seething cauldron of fire. Upon this supposition are explained the phenomena of **Volcanoes, Hot-Springs,** and **Earthquakes.***

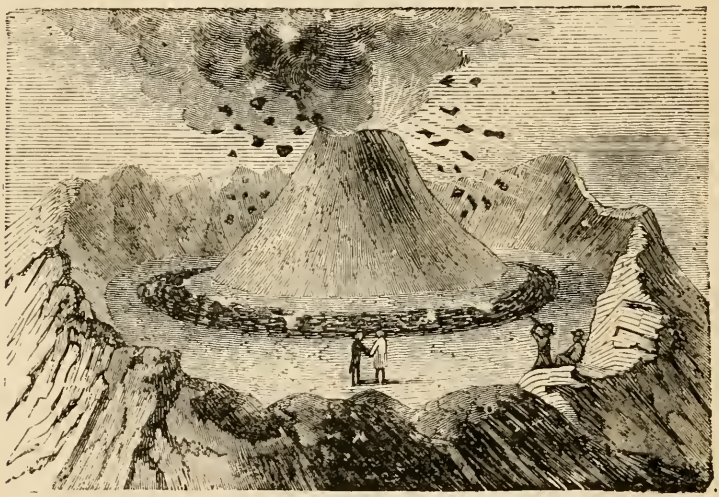
VOLCANOES.

67. Volcanoes, or Burning Mountains, emit from their sides or summits smoke, ashes, sulphurous vapours, flames, and torrents of melted lava. Volcanoes are not necessarily mountains: the volcanic action may originate on level ground, either on the land or at the bottom of the sea; but the ejected matter, gradually increasing around the vent, in the course of time forms a mountain. They are generally of large size, of a conical form, with a cauldron-like hollow at the top, termed the *crater*. They are either continuously **active, intermittent,** or **extinct.** The last class are those of which history records no instance of activity, such as the Auvergne Mountains in Central France. Stromboli is an example of the first class—its unceasing fires being styled "the lighthouse of the Mediterranean." But the larger number have periods of repose, amounting sometimes to centuries. The activity and frequency of eruptions seem to be greater when the elevation is low.

Volcanic Phenomena.—In a state of rest, volcanoes at all times discharge smoke and jets of watery vapour, but on the eve of an eruption the snows of the summit (if

* It is proper to mention that this theory of the central heat of the earth is now disputed by some eminent writers.

above the snow-line) melt, causing sudden and destructive torrents. Subterraneous hollow sounds are heard, and the earth vibrates beneath the feet, sometimes for weeks; dense black smoke hangs in vast heavy masses over the summit. Then come flashes of flame, volleys of red-hot stones, discharged with reports like those of a park of artillery, and projected to a height of two or three thousand feet, while showers of ashes and scoriæ (or dust) are borne by the winds for many miles around. The climax is reached when the lava (or melted minerals) leaps forth in living fountains of fire from the summit and heaving flanks of the mountain.



CRATER OF VESUVIUS DURING AN ERUPTION.

The red-hot stones are often of great size and weight, and have been projected to a distance of nine miles. From Vesuvius, in 1779, the melted lava, mixed with scoriæ and stones, were thrown to a height of 10,000 feet, or about two miles; and on one occasion the flames of Cotopaxi, in South America, rose 3000 feet above the edge of the crater, and the noise was heard 600 miles off. The ashes and scoriæ darken the air for hours and even days. In an eruption of Tomboro, in Sumbawa (East Indies), in 1815, the ashes strewed the streets and houses of Java, 300 miles off, and were found floating two feet thick on the sea near Sumatra, more than 1000 miles distant. "The ashes and scoriæ were suffi

cient to form three mountains equal to Mont Blanc, or to cover the whole of Germany two feet deep." In 1845 ashes from Mount Hecla, in Iceland, reached the Orkney Islands, more than 700 miles off. It was with ashes from Vesuvius, in A.D. 79, that the cities of Herculaneum and Pompeii were destroyed, being buried to the depth of 70 to 112 feet.

VESUVIUS NOT IN A STATE OF ERUPTION.

The lava at first is of the consistency of honey, resembling the slag of a furnace, and hence in general proceeds in majestic slow-winding streams of fire, varying in speed from two miles an hour to two miles in ten years. Its heat is excessive, and it cools slowly; at Mount Jorullo, in Mexico, forty-five years after its eruption, Humboldt found a mass of lava 500 feet thick, so hot that "a cigar might be lighted at any of the cracks a few inches below the surface." The amount of lava ejected at one eruption is enormous. "The most prodigious fiery flood on record proceeded from Skáptaa Yokul, in Iceland, in 1783. The lava flowed in two nearly opposite streams, 50 miles in one direction and 40 in the other, with respective breadths of 15 and 7 miles, and an average depth of 100 feet. The mass has been calculated at 20 billion cubic yards, or 40 billion tons, which, accumulated, would cover London with a mountain rivalling the Peak of Teneriffe."

68. Distribution of Volcanoes.—Volcanoes are not confined to any one region or climate of the earth, but by far the greater number are found in islands or mountain

chains near the sea-coast. The only great exception to this arrangement is the volcanic chain of Thian-Shan in Central Asia, more than 1500 miles from the sea. By far the greater number of volcanoes, and of the active ones, no less than about two-thirds belong to the islands and shores of the Pacific.

"Along the whole chain of the Andes, in Central America and Mexico, almost all the loftiest peaks are volcanic or trachytic; and the earthquake and eruption are normal, and not exceptional events. Along the north-west of the American continent, the chain of newer igneous formations is almost continuous, and in Oregon attains an immense development. . . . . The line is continued along the coast to the extreme west point of the continent, on the Aliaskan peninsula (which is igneous), and thence to Kamtchatka by the Aleutian Isles, where eruptions are frequent, and a new island rose in 1814; thence again in almost unbroken succession, by the Kurile and Japanese islands (where outbreaks are frequent, and of excessive violence), through Formosa and the Philippines down to the Indian Archipelago, where Sumatra, Java, Sumbawa, and Floris, exhibit a perfect rookery of volcanoes, the scene of one of the most dreadful eruptions of modern times (that of Tomboro, in 1815)." No active volcanoes appear in Australia or Tasmania, but, in a line conforming to the curvature of their coasts, the series is prolonged through Solomon Isles, New Hebrides and Friendly Isles, to New Zealand, and "thence even to the active volcanoes of Mount Erebus, and the extinct one of Mount Terror in South Victoria Land."—*Sir John Herschell's Physical Geography.*

Eastern Africa is possessed of several important volcanoes. The principal seat of volcanic activity in Europe is in the Mediterranean, the whole of Italy and Sicily, through 700 miles of length, being specially volcanic. Of the various vents, Vesuvius, near the city of Naples, is the only one on the mainland. Etna, in Sicily, nearly 12,000 feet high, maintains such a connection with Vesuvius, that when the one is active, the other is silent. Stromboli, in one of the Lipari Islands, and Santorin, in the Grecian Archipelago, are the other chief summits

in this region. Mount Hecla, although not the highest and largest, is the best known, because the most accessible, of the seven volcanic peaks of Iceland. The island of Jan Mayen, to the north of Iceland, is also volcanic, and belongs to the North Atlantic system. The island of Java has the unhappy pre-eminence of being the greatest seat of volcanic action; out of 80 vents in the Sunda Isles, no less than 43 belong to Java alone. A peculiar and awful interest attaches to a portion of the table-land of Quito, which has been supposed to be merely the dome of an enormous vault hollowed out by the action of volcanic fires. Forty-five volcanoes have been counted between the city of Quito and the Pacific coast. The largest and most terrific volcano known is Kirauea, in Hawaii, one of the Sandwich Islands, in the Pacific. It presents the appearance of a vast lake of fire, 200 or 300 feet below the surrounding plain, with more than 50 craters, one-half of them belching forth smoke and flame, and streams of lava, which "roar and boil in endless torture."

The number of active volcanoes is variously estimated, but Professor Ansted gives the following table of their distribution:—

Position of Volcanoes.	Principal Cones.
Atlantic Ocean—Northern Part,	10
,, Central Part,	10
,, Southern Part,	3
Gulf of Mexico—West Indian Islands,	10
Mediterranean—Sea and Coasts,	5
Red Sea and African Coast, adjacent,	2
Indian Ocean (West side),	3
Asiatic Continent,	5
Asiatic Coast and Islands—Southern Part,	75
,, Eastern Part,	110
Eastern Archipelago and Pacific Ocean,	16
America—Northern Series,	45
,, Central Series,	45
,, Southern Series,	54
Antarctic Land,	3
Total,	396

69. **Classification of Volcanoes.** — Volcanoes are divided into two great classes of **Central** and **Linear**.

(1) A **Central** system consists of a group of volcanic vents surrounding one principal cone, such as those of the Canary Islands with the central Peak of Teneriffe (Pico de Teyde).

(2) A **Linear** system has its series of openings lying

in the same line of direction, and at no great distance apart, such as the great chain of the Andes and the Asiatic islands. The latter class is the more numerous, for out of 407 active and extinct volcanoes, only 42 are central, while 365 are linear; the former consists of nineteen groups or systems, the latter of twenty-two.

70. Effects of Volcanoes.—To the energy of volcanic action are attributed the elevation and subsidence of great lines of coast in various regions of the globe, and the formation of numerous islands, and even of entire continents. Indeed, new islands are still being at intervals thrown up by submarine volcanoes, some of which disappear again in a few months, while others remain firm, or partially subside beneath the waves, and form dangerous shoals. Hills, too, of considerable mass still rise within a brief period: Mount Jorullo, to the west of the city of Mexico, in 1759, rose out of the plain, along with several square miles around it. In the space of two days it was raised 1375 feet—its height above the sea being now 4265 feet.

As special features of volcanic action may be mentioned the **solfataras** ("sulphur grounds") and **fumeroles** ("smoke vents") of dormant or extinct volcanoes; **mud-volcanoes**, as in Sicily, Java, and Trinidad (in the West Indies); the **Fires of Baku**, or "fields of fire," west of the Caspian, the sacred region and place of pilgrimage to the Guebres, or fire-worshippers; the **Fire-springs** and **Fire-hills** of China; and the **Geysers**, or boiling springs of Iceland.

Geysers.—The Geysers ("roarers") are a group of hot springs in Iceland, thirty-six miles north-west of Mount Hecla, and within sight of it. They are more than fifty in number, and of various sizes—some tranquil, others boiling regularly or at intervals, and all are filled with water clear as crystal, and surrounded by silicious incrustations formed from the silica infused in the water. The two largest are, the Great Geyser and the New Geyser or Strokr ("churn"), about 100 yards apart. The Great Geyser consists of a circular pool or basin, 72 feet at its greatest diameter, and 4 feet deep, situated on the summit of a mound of silicious deposit, 15 feet above the neighbouring ground. In the

centre is a pit 8 feet wide and 83 feet in perpendicular depth, up which heated water is constantly ascending. Every few hours the water rises in jets a few feet above the surface with a rumbling noise, and again subsides; but about once a-day this tumult ends in a terrific outburst, which may last about fifteen minutes, when the water is thrown in jets to a height of 60 to 80 feet, obscuring the country around with volumes of steam. The water at the edge of the basin has a temperature of 187° Fahrenheit, but immediately before an eruption that at the bottom of the deep tube or vent has been ascertained to be no less than 261°, or 49° higher than that of boiling water.

EARTHQUAKES.

71. The volcano and the earthquake are intimately connected, and are evidently phases of the same phenomenon, viz., the high temperature of the interior of the earth. The latter, indeed, is frequently the precursor or concomitant of the former.

Earthquakes may be defined as more or less violent commotions of the surface of the earth. They are of several kinds — **tremulous, vertical, horizontal,** and **rotatory.**

The **tremulous,** common in Chili and neighbouring countries, are least destructive; the **vertical,** or perpendicular, act like the explosion of a mine; the **horizontal,** common to all great convulsions of the earth, resemble the undulations of the waves at sea, and progress at a speed of 20 to 30 miles in a minute; the **rotatory** are most rare, but most destructive. The direction of the concussions is either linear, like that of Guadaloupe (1842), which extended 3000 miles in a right line, and 60 to 70 in breadth; or circular, like that of Calabria (1783); or elliptical, like the great earthquake of Lisbon (1755). The area of concussion is sometimes immense, and the devastation fearful.

The earthquake of Lisbon was felt over an area four times the size of Europe, or one-twelfth of the superficial area of the globe. It shook the continent of Europe, and rocked the waters of Lake Ontario in North America, and the Atlantic Ocean was so agitated that many islands in the West Indies were overflowed, and

the waves rose 50 feet at Lisbon above their usual level. The whole city, with 60,000 souls, was destroyed in six minutes. In 1812, the city of Caraccas, with 12,000 inhabitants, perished under three successive shocks in fifty seconds. In the east of Calabria, in an area of 22 square miles, 200 towns and villages, with 100,000 inhabitants, were destroyed. On the 13th of August, 1868, occurred the great earthquake of South America, the most fearful and destructive that has taken place within the present century. It was confined to the west side of the Andes, but these mountains were shaken to the height of 13,000 feet. It was accompanied by several lesser convulsions in California, Vancouver's Island, New Zealand, and the British Isles; and the ocean was disturbed over an area of 30 million square miles, nearly equal in extent to that of the Old World. Whilst many cities in Peru and Ecuador were destroyed, no less than from 20,000 to 30,000 of the inhabitants of Ecuador perished.

These appalling devastations sometimes happen without warning, but generally they are preceded by loud detonations from underground, which resemble the roll of thunder, the rattling of heavy waggons over a stone pavement, or the irregular firing of cannon.

72. **Earthquake Districts.**—The regions visited by earthquakes are in general the same as the volcanic districts, but the most violent convulsions generally happen remote from the seats of active volcanoes. The latter serve as vents or safety-valves to allow the elastic forces beneath the crust to escape, whereas in remote regions the surface is convulsed and torn by the raging elements struggling to get free. The great earthquake districts are those of the **Mediterranean Basin, Central Asia, Iceland,** and **America.** The first two are connected, and extend from the Azores to Lake Baikal—the longest and most regular zone of volcanic action in the world. The line of concussion is determined by the direction of the principal mountain chains. The American district lies chiefly on the west coast, along the line of the Andes; but it also extends along the north coast of South America, and into the West Indian Islands.

The **Effects of Earthquakes** are, the elevation and depression of great tracts of land, the opening of great fissures, and violent oceanic movements. After the great earthquake of 1822, the coast of Chili was permanently

raised from three to four feet for a distance of 100 miles. On the other hand, whole cities and mountains have been engulfed in the sea.

EARTHQUAKE FISSURES IN CALABRIA.

73. **Uses of Volcanic Agency.**—It is originally due to volcanic agency that the metals and the rocky strata so useful to man have been brought within his reach, and that the surface of the earth is not one uniform level, but is diversified with mountain and valley, plain and plateau. But the unceasing influences of aqueous and atmospheric agency, such as frost and rain, wind and wave, if not counteracted, would, in the course of ages, reduce the higher portions of that surface to a dead level; even the sea would usurp the place of the land, and the conditions of animal and vegetable life would be seriously disturbed. Such processes of disintegration and waste are indeed constantly, though slowly, taking place around us, as they have ever been in the history of the structure of the globe; but volcanic forces are ever and anon engaged in the process of upheaval and reconstruction. By the two

great antagonistic principles of fire and water the general equilibrium of the crust of the earth is preserved. While extensive areas of subsidence occur in some regions, as extensive areas of elevation occur in others: thus, the west coast of Norway and the northern shores of the Baltic have been raised hundreds of feet, and are still rising at the rate of four feet in a century; the south of Sweden and west of Greenland, on the other hand, are slowly subsiding beneath the waters. Raised sea-beaches and submarine forests afford similar evidences of elevation and depression in our own island. Not altogether, therefore, by a mere figure of speech, does the poet, in the well-known lines, speak of the time—

> "When Britain first, at Heaven's command,
> Arose from out the azure main."

CORAL FORMATIONS.

74. Besides the volcano and the earthquake, another great agency is at work, incessantly, yet peacefully, in changing the surface of the globe and preparing abodes for man. Over extensive areas within the Tropics, in the Indian and Pacific Oceans, particularly the latter, immense numbers of islands and reefs have been formed, and are still being formed, by coral insects. These creatures are not properly insects, as they are commonly called, but polypi. They are of various sizes, shapes, and colours, and they abound in myriads. They cease to live at a greater depth than from 25 to 30 fathoms, and from this depth they build up to the surface perpendicular walls of coral—the material being carbonate of lime, secreted from the waters of the ocean, and cemented into the hardest of rock.

"The reef, rising in the form of a gigantic cauliflower," at length reaches the surface; fragments of rock are thrown up by the violence of the surf, and raised above the water; these arrest trunks of trees and other drift-wood, which collect into a mass. Vegetation speedily

appears upon soil and sand formed from the pulverized rock; the cocoa-nut tree and stately palm shoot up, and, descried in the horizon, attract sea-fowl and other birds, and last of all, man himself, to the newly created island. Sometimes the mass has been raised by submarine forces —the volcano and the earthquake; but there are also extensive areas of subsidence where the coral formations have sunk and again been built upon.

Coral formations are of three kinds :—**Lagoon-islands or atolls, barrier-reefs, and fringing-reefs.**

(1) **Lagoon-islands or atolls** are the most numerous class, and consist of a low belt of coral, about a quarter of a mile broad, surrounding a lagoon or isolated portion of the ocean, of various forms and dimensions. "A strip of land, a few hundred yards wide, is covered with cocoa-nut trees, above which is the blue vault of heaven. This band of verdure is bounded by a beach of glittering white sand, the outer margin of which is encircled with a ring of snow-white breakers, beyond which are the dark-heaving waters of the ocean. The inner beach encloses the still clear waters of the lagoon, resting, in its greater part, on white sand, and, when illuminated by a vertical sun, of a most vivid green." **Encircling-reefs** differ from these only in having several islands within the enclosure, such as Otaheite in the Society Islands. By openings or channels in the reefs, vessels may enter the interior expanse, and find excellent harbourage. These openings occur invariably on the leeward side; and that side is always on lower ground than the windward.

LAGOON ISLAND OR ATOLL. VOLCANIC ISLAND.

Atolls occur in three main groups—the Caroline Archipelago, north of the Equator; the Low Archipelago, south of the Equator; and the Laccadive, Maldive, and Chagos groups, in the Indian Ocean.

(2) **Barrier-reefs** extend in a straight line in front of a continent or large island, at some distance from the land, such as the "Great Barrier Reef" to the north-east of Australia, more than 1000 miles in length, from 200 yards to one mile in breadth, and from 20 to 70 miles from shore. That to the west of New Caledonia is 400 miles long, and from 8 to 16 miles from shore. The Fejee and Society Islands have also barrier-reefs.

(3) **Fringe-reefs** are small narrow belts of coral that closely line the shores. They abound among the islands of the Indian Archipelago and South Pacific, as well as on the shores of Madagascar, Eastern Africa, and the West Indies.

These three forms of reef are all due to the same cause—the gradual submergence of the land. First, the coral insects built the *fringe-reef* close in shore. As the island sank, a smaller surface was protruded, so as to leave more space between it and the reef; and, as the insects still built upwards, it became a *barrier-reef*. Lastly, the island disappeared beneath the waters, leaving the lagoon inside the *atoll*. The atoll thus resulted from the barrier-reef, and the barrier reef from the fringing-reef. Such is Mr. Darwin's theory.

EXERCISES.

1. Write out in your own words an account of the two great classes of rocks. Give the ten systems of rocks in descending order, and divide them into periods or epochs. Name mountain ranges containing gold besides those mentioned in the text. Which mountains are the richest in metals? What two minerals are in general found in close connection? and what is the advantage of this arrangement? Which are the useful, and which the precious metals? What two great agencies are employed in operating upon the crust of the earth? If heat increases in descending towards the centre of the earth at 1° for every 54 feet, at what depth would we reach the boiling point of water (212°F.), and of iron (2800°F.)? What proportions do these depths bear to the diameter of the earth?

2. Describe in your own words the phenomena attending a volcanic eruption. Group the volcanoes of the globe according to ocean basins. Which volcanic systems are at the entrances of the Arctic Ocean? Which is the most northerly? Which the most southerly? Trace on the map those along the Pacific seaboard. Where are volcanoes farthest inland? Which continent has most? Which fewest? What part of the mainland of Asia has most? Name those of Europe—what class do they belong

to? and how are they situated? Name the principal volcanic island-chains. Name solitary volcanic islands. Give some of the principal volcanic peaks. What mountains bound the earthquake district of the Mediterranean? Name a few of the greatest earthquakes, with their dates. Draw a chart showing the distribution of volcanoes and earthquakes. Describe in your own words coralline formations. Name the principal coralline groups in the Pacific.

CHAPTER VII.

DISTRIBUTION OF PLANTS.

General Characteristics of Plants—General Distribution—Zones of Vegetation—Ascending Zones of Vegetation—Botanic Regions—Agricultural Zones—Chief Vegetable Products and the Countries of their Production.

75. General Characteristics of Plants.—Vegetation is universally diffused over the globe, extending even to the regions of perpetual snows and the extreme depths of the ocean. For even on the snows of the Arctic Zone, and of the higher Alps and Pyrenees, may be seen the *palmella nivalis*, or *red snow*, which is a minute species of plant. Light, heat, and moisture are the principal conditions conducing to the growth of plants; but the entire absence of moisture alone proves fatal. The total number of species of plants has been estimated at 120,000. These are divided into two great classes, viz.:

I.—**Cryptogamous,** or *flowerless* plants; as mosses, lichens, fungi, ferns, and sea-weed;

II.—**Phanerogamous,** or *flowering* plants, which consist of—

(1) *Endogenous* plants, whose stems increase from within; as the numerous grasses, lilies, and palms; and,

(2) *Exogenous* plants, whose stems increase from without; such as the forest trees (deciduous) and most flowering plants and shrubs. The first class form only $\frac{1}{8}$ of

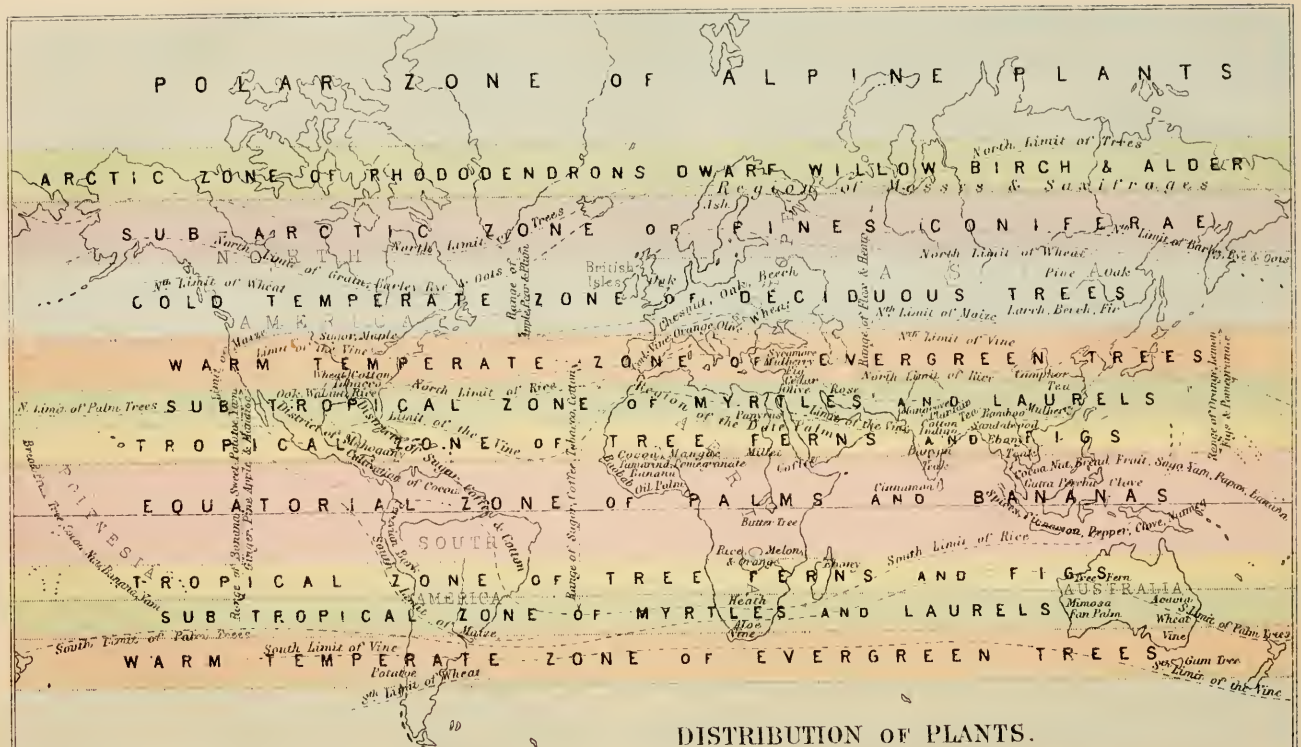
the whole, and, with the important exception of ferns, are most abundant in Polar and Alpine regions, but decrease towards the Equator. On the other hand, exogens in Tropical regions are to the endogens as four to one; in the Temperate as six to one; and in the Arctic not more than two to one.

76. **General Distribution.**—The elements of light, heat, and moisture, being in greatest intensity within the Tropics, there we find the greatest development of vegetable life; and a gradual declension takes place as we proceed towards either Pole.

INTERTROPICAL vegetation is the most varied and luxuriant, and of the noblest kinds; the trees are lofty and huge, with large, bright, evergreen leaves, and splendid flowers, and are matted over with gigantic climbers and parasites, so dense as to make the forest impenetrable. Aromatic shrubs abound, while reeds rise to the height of 100 feet, and rigid grasses to 40. To this region belong the palm, the loftiest of trees; the baobab, the thickest; and the banyan, the shadiest.

In the TEMPERATE REGIONS more hardy forms and families appear: the large towering evergreen trees give place to deciduous trees (oak, ash, elm, etc.); the tall rigid grasses of the dense jungle to vivid green meadows, with tender herbs; and the vine and cereal grasses are cultivated and brought to perfection. Then succeed dark forests of fir and pine at the sea-level towards the north of Europe, Asia, and America, but at from 10,000 to 12,000 feet of elevation within the Tropics. These, in their turn, gradually disappear with increase of latitude.

The trees are dwarfed by the cold into mere shrubs, such as the dwarf willow, birch, and alder. Although the rhododendron is the characteristic plant of the Arctic Zone, it is found abundantly only on high elevations, such as the Himalayas and the Alps. The degeneration of vegetable life continues till lichens and mosses, its lowest forms, are reached in the REGIONS OF THE POLES.



DISTRIBUTION OF PLANTS.

ZONES OF VEGETATION.

Zones.	Characteristic Plants.	Zones.	Characteristic Plants.
Equatorial, . .	Palms & Bananas.	Arctic,	Rhododendrons, with Dwarf Willow, Birch, and Alder.
Tropical, . . .	Tree Ferns & Figs.		
Sub-Tropical, .	Myrtles & Laurels.		
Warm Temperate,	Evergreen Trees.		
Cold Temperate,	Deciduous Trees.	Polar,	Alpine Plants.
Sub-Arctic, . .	Pines (Coniferæ).		

It is only in a general sense that these zones are limited by parallels of latitude; they are bounded rather by lines of equal mean summer temperature, so that, strictly represented, their limits would present undulating lines. But they are necessarily ill-defined, as they often overlap or run into each other, from a greater or less number of species being common to two conterminous zones.

Ascending Zones of Vegetation. — Temperature decreases with altitude about 1° for every 350 feet. In ascending a lofty mountain near the Equator, the traveller passes through successive zones of vegetation analogous to those between the Equator and the Poles. "A few hundred feet more or less of elevation is sufficient to change the whole physical aspects of a country, — converting arable lands and vineyards into pasture lands, pasture lands into pine forests, and pine forests into regions of everlasting snow and glaciers." "We may begin the ascent of the Alps, for instance, in the midst of warm vineyards, and pass through a succession of oaks, sweet chestnuts, and beeches, till we gain the elevation of the more hardy pines and stunted birches, and tread on pastures fringed by borders of perpetual snow."

Botanic Regions.—Independently of climate, certain forms of vegetation are restricted to certain areas, or are predominant within them. Hence botanists sub-divide the earth into twenty-five botanic regions, such as the region of mosses and saxifrages lying within the Arctic Circle; the region of the tea-plant and camellia in

Eastern Asia; the region of palms in South America, east of the Andes and between the Equator and the Tropic of Capricorn, etc. America excels every other quarter of the globe, not only for the luxuriance and splendour, but for the variety of its flora. It has more than double the number that are natives of Europe; Asia has fewer than Europe; Oceania fewer than Asia; and Africa the least. Great mountain chains separate botanic regions as effectually as the ocean; and the same families do not occur in regions far apart in which the climatic and

VERTICAL DISTRIBUTION OF PLANTS.

other conditions appear the same, but similar or *representative* species occur. The heaths of Europe have representatives, more rich and numerous, in South Africa; but heaths are entirely absent in America. The *Cactus* plants of South America are represented by the *Euphorbiæ* of South Africa. On the other hand the rose, with the common fruits and food-plants of Europe, are unknown in the Southern Hemisphere. Australia possesses the most singular vegetation known: "persistent-leaved trees, with hard narrow leaves of a sombre melancholy hue, and whole shadowless forests of leafless trees." Such are the gum-trees and leafless acacias.

77. **Agricultural Zones.**—The cultivated food-producing plants are arranged in the following order, from the Tropics northwards:—

(1) Zone of rice, millet, and maize;
(2) Zone of maize and wheat;
(3) Zone of wheat, rye, buckwheat, pease, and beans;
(4) Zone of barley, oats, bere, and the potato.

Rice has its favourite seat in South-Eastern Asia, and, along with pulse, feeds more human beings than any other grain; millet (also called *Durra*) is grown extensively in the countries around the Red Sea; and maize is most widely diffused in America—extending from Chili to Canada. The common grains of Europe, wheat, rye, etc., are supposed to have been transferred from the North

BREAD FRUIT.

of Persia and India, and the cereals generally are the most easily transferred of vegetable products. The potato, the most widely distributed of food-yielding plants, is a native

of Chili and Peru; it is grown everywhere except in inter-tropical lowlands, where it is replaced by the *batata*, or sweet potato, in the New World, and by the *yam* in the East and West Indies. Tobacco, also from America, is the most widely distributed luxury; it grows everywhere within the Tropics, and also beyond them, but not so far north as the potato. The tea-plant has its favourite seat on the hilly grounds of Southern China, beneath the Tropic of Cancer; the coffee-plant, a native of Kaffa in Eastern Africa, is produced most largely in Arabia, Ceylon, Java, and Brazil; and the vine is of the Warm Temperate Zone. Food-yielding trees within the Tropics are the palm, the plantain or banana, the baobab, the manioc, and bread-fruit tree; and to the same region belong most of our spices and the sugar-cane. Of clothing plants, cotton, the most extensively used material of clothing, flourishes on both sides of the Tropics, and in both the Old World and the New; while hemp and flax are the only clothing plants of the Temperate Zone.

VEGETABLE PRODUCTS AND THE CHIEF COUNTRIES OF THEIR PRODUCTION.

Almonds—France, Spain, Italy, the Levant.
Aloes—Bombay, Arabia, Socotra, Cape Colony, the Levant, West Indies.
Arrow-root—East and West Indies, Bermudas, South America, Africa.
Banana or **Plantain**—All tropical and sub-tropical countries.
Batata or **Sweet Potato**—All tropical and sub-tropical countries.
Barley—Chiefly Belgium, Holland, Prussia, Denmark, Britain; but generally from 45° to 69½° N. latitude in the Eastern Hemisphere.
Bread-fruit—South Sea Islands and East Indies.
Cacao or **Cocoa**—All tropical and sub-tropical countries.
Cocoa-nuts—All tropical and sub-tropical countries.
Camphor—China, Japan, Cochin-China, Java, West Indies.
Caoutchouc or **India-rubber**—East Indies, Guiana, Brazil, West Indies.
Capers—South of France, Italy, Sicily, and Mediterranean countries.
Chestnut—Asia Minor, Sardinia, and south of Europe.

Chicory—England and continent of Europe.
Cinnamon—Ceylon and West Indies.
Cloves—East Indies (Moluccas), Bourbon, Mauritius, West Indies.
Coffee—Arabia, West Indies, Brazil, East Indies, Bourbon, Guiana.
Cork—South of Europe (chiefly Spain and Portugal), and north of Africa.
Cotton—All countries within 35° N. and 35° S. lat., especially United States, West Indies, Brazil, Egypt, East Indies.
Currants—Greece, including the Ionian Islands.
Dates—North of Africa, Arabia, Persia, India.
Ebony—India, Ceylon, Mauritius, Madagascar.
Esparto—South of Europe, especially Spain.
Figs—Tropical and sub-tropical countries, especially around the Mediterranean.
Flax or **Lint** and **Hemp**—The temperate parts of Asia and North America, Egypt, Belgium, Russia, south shores of the Baltic, and Ireland.
Ginger—East Indies, West Indies, Sierra Leone.
Indigo—India, Egypt, West Indies, Mexico, Central America, Brazil.
Jute—India.
Lemon—Countries on the Mediterranean, Portugal, India, Brazil.
Logwood—Mexico, Central America, West Indies.
Madder—Holland, Italy, Turkey, India, China.
Mahogany—West Indies, Honduras, South America.
Maize or **Indian Corn**—America generally (particularly United States), South of Europe, Germany, Africa, Australia.
Millet or **Durra**—East Indies, South of Europe, Egypt, Central Africa, West Indies.
Manioc or **Cassava**—Tropical America (Brazil, West Indies, etc.) and Africa.
Nutmeg—East Indies, also India, West Indies, Brazil.
Oats—Britain (especially Scotland), Continental Europe, North America, and Australia.
Olive—Syria and other Asiatic countries, and south of Europe.
Opium—India, Persia, Asiatic Turkey, Egypt.
Oranges—Azores, Malta, Sicily, Spain and Portugal.
Pine-apple—West Indies, and many other tropical and sub-tropical countries.
Pine-timber—The Baltic countries, and British North America.
Potato—America (except within the Tropics) and Europe.
Prunes—France.
Raisins—Spain and Asiatic Turkey.
Rhubarb (Drug)—Inland China, Tibet, and Chinese Tartary.
Rice—India, China, South-east of Asia, Japan, Egypt, Southern States of North America.

Rosewood—South America, and Malabar in India.
Rye—North of Europe, and some parts of Asia.
Sago—Borneo, Singapore, India, Ceylon.
Sugar (Cane)—West Indies, Brazil, Demerara, Venezuela, East Indies, India, Mauritius.
Sugar (Beetroot)—France, Belgium, Germany.
Sugar (Maple)—British North America and United States.
Tea—China, Assam (India).
Teak—East Indies, India, Further India, Africa.
Tobacco—United States, Germany, Turkey.
Walnut—South of Europe, the Himalayas, and North America.
Wheat—United States (Northern), Germany, Russia, France, British North America.
Wines—Spain, Portugal, France, Germany, Hungary, Cape Colony, Australia.
Yam—East and West Indies.

EXERCISES.

Write out an account of the general characteristics and distribution of plants. Learn from the map the distribution or chief localities of (1) food-producing plants; (2) clothing plants; (3) timber-trees; (4) medicinal plants; (5) spices; (6) beverages, etc. Which of these are grown in Britain? Which of their products are imported? Name as many representative species and as many transferred species as you can, besides those mentioned in the text. Name the countries embraced under each of the Zones of Vegetation. Draw a sketch of the Ascending Zones of Vegetation; also, map of Plant Distribution.

CHAPTER VIII.

DISTRIBUTION OF ANIMALS.

General Distribution—Distribution according to Zones—Marine Animals—Animals Peculiar to Certain Regions—Representative Species—Transferred Species—Chief Animal Products and the Countries of their Production.

78. General Distribution.—There are 250,000 known species of animals. Being dependent upon climate and

food, they are, like plants, more or less restricted in their habitats; and they have also, in a general way, both a horizontal and a vertical distribution. Within the Tropics animal life is also most exuberant in point of size, numbers, strength, and beauty: the Temperate Zones excel, in these respects, the Arctic and Antarctic, with the exception of marine animals and sea-fowl, which are most abundant in the Polar regions. The inhabitants of the rich and sheltered lowlands are distinct from those of the mountain slopes, and these again from those of the higher and colder elevations. In the same manner, the sea-fish of the shallow shore differ from those of the deeper ocean.

The TROPICAL REGIONS are the abode of the larger carnivora, as lions, tigers, etc.; the elephant, rhinoceros, hippopotamus; the crocodile, turtle, boa, and larger reptiles; the ostrich, flamingo, peacock, parrots, humming-birds, and others of varied and brilliant plumage; the giraffe and zebra, apes and monkeys; while insect life is by far the most exuberant, brilliant, and varied. Mosquitoes abound in America, but are found in most tropical countries; locusts infest the shores of the Mediterranean and the East generally; ants abound chiefly in hot and dry countries—the termites in Africa, the white ants in India. In the swamps of the great rivers of tropical America, the air is one dense cloud of poisonous insects to the height of twenty feet.

The TEMPERATE ZONES are the head-quarters of the ox, bison, buffalo, goat, sheep, deer, camel, and other ruminants; the wild boar, wolf, fox, and beaver; the eagle, turkey, goose, grouse, pheasant, etc.

The ARCTIC fauna has greater uniformity, having few species, but many individuals, with a less varied and more sombre colouring. The reindeer, musk-ox, brown and polar bears, Arctic fox, and numerous fur-bearing animals, are peculiar to the Arctic Zone. The countless multitudes of sea-fowl that frequent its waters are migrants from more southern latitudes, and reptile life

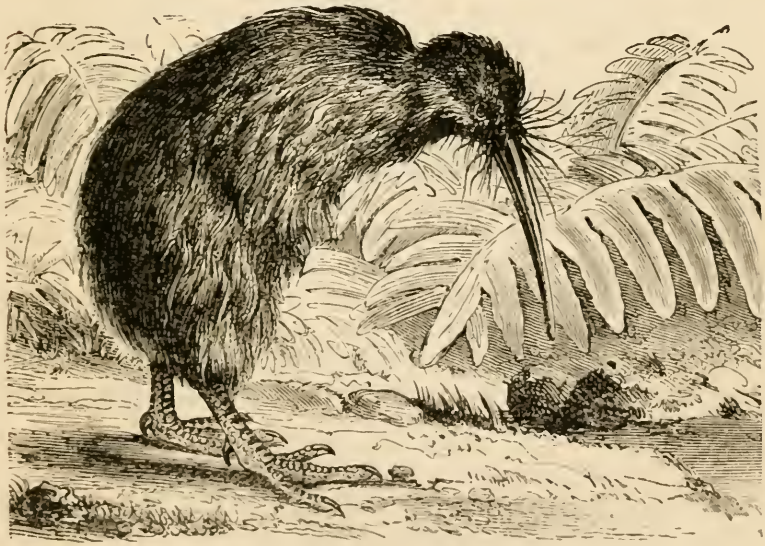
is unknown. The whale, the walrus, and the seal of the polar seas, seem the counterparts of the elephant, the rhinoceros, and the hippopotamus of tropical climates.

79. **Marine Animals.**—The fishes and shell-fish (and even the sea-weed) of the Torrid Zone are characterized by the variety of their genera and species, and they are of the most varied and brilliant tints. But the fish of warm waters are inferior in flavour and nutritious qualities to those of colder seas. The true pearl oyster is confined to the Indian seas. The shark inhabits the Torrid Zone; the tunny, the Mediterranean; while the herring, the cod, the pilchard, and the salmon, reach perfection only in colder latitudes. The coral insect builds its structure only in tropical or sub-tropical expanses. The sperm whale is never found out of the tropical areas of the Pacific, and the "right" whale never out of colder latitudes.

80. **Animals Peculiar to Certain Regions.**—Each quarter of the world has some one class of animals predominant: Europe and Asia have the ruminantia; Africa has land-tortoises; North America, birds of passage; South America, the edentata, or *toothless animals*, such as the ant-eater, armadillo, and sloth; Australia, the marsupialia, or *pouched animals*, such as the kangaroo. Almost every country, too, has animals peculiar to itself: the kangaroo and ornithorynchus are confined to Australia, the red grouse to Great Britain, the canary to the Canary Islands, the ichneumon to Egypt, the hippopotamus and giraffe to Africa, true humming-birds and prehensile-tailed monkeys to America; the camel to the dry desert regions of Africa and Asia, and the reindeer to the Arctic Zone. The chamois and ibex are peculiar to the Alps, the llama, the alpaca, and the condor to the Andes of Peru, the yak or cashgow to the table-land of Tibet. The tsetse, an insect of South Africa, whose bite is death to certain animals, is often confined to the region lying on one side of a river. In the South Sea Islands, just as in Ireland, there are no serpents; and all the

reptiles of the New World are distinct from those of the Old. There is not a single ruminant animal native to Australia, New Guinea, Madagascar, and the South Sea Islands; and of the whole 186 species of ruminants, only 24 belong to America.

The fauna (or animal-life) as well as the flora (or plant-life) of Australia is the most peculiar in the world; whilst its native species are all unknown elsewhere, except in Tasmania. Three great orders of animals are entirely awanting,—viz., the ruminantia, or those that *chew the cud*, like the ox or sheep; the pachydermata, or *thick-skinned* animals, like the horse or elephant; and the quadrumana, or *four-handed* animals, such as apes and monkeys. It has only seven species of carnivora, viz., 4 seals, 2 bats, and 1 dog, while South America has only 13.



THE APTERYX.

The complete isolation of insular groups is still more remarkable. Out of 26 species of land birds in the Galápalos islands, one only is known in any part of the world. Australia has 320

species of birds, and of these 290 are found nowhere else. A like isolation is seen in New Zealand, 1150 miles distant, whose most remarkable group is that of the wingless birds (*Apteryx*).

81. Representative Species.—Regions distant from each other, having similar conditions of life, just as with plants, have not the same, but often representative or analogous species of animals. Thus, the camel of the Old World is represented by the llama and alpaca of the New; the lion and tiger of the Old by the puma and jaguar of the New; the ostrich of Africa by the rhea of South America and the emu of Australia; and the crocodile of the Nile by the gavial of the Ganges and the alligator or cayman of the Amazon and Orinoco. The tapir of America represents the elephant, and the peccary the hog.

82. Transferred Species.—Whilst certain animals, such as the camel and the reindeer, cease to exist away from their peculiar habitat, certain other species, like plants, have been transferred by man from their native regions to others for the purposes of convenience or luxury. Thus, all the domestic animals, the ox, horse, sheep, dog, etc., many birds, and even vermin, such as rats and mice, have followed man over the habitable globe. "The pampas of South America swarm with wild cattle and horses, the descendants of European breeds." Europe itself owes the domestic fowls (except the turkey from America), and probably also the horse, to Asia. But the dog is the only animal that can adapt itself to all climates, and thus become the never-failing companion and devoted friend of man. Beyond Europe, however, and the countries settled by Europeans, the dog has never been domesticated.

ANIMAL PRODUCTS AND THE CHIEF COUNTRIES OF THEIR PRODUCTION.

Cochineal (Insect)—Mexico, West Indies, Teneriffe, Algeria.

Fish—Herring, haddock, oyster, cod, or ling, in the British seas—cod also in Newfoundland; salmon, in British rivers; tunny, anchovy, and sardines, in the Mediterranean; lobsters and

turbots, from Norway; whale and seal, in the Greenland seas; the sperm whale, in the South seas.

Furs—Hudson's Bay Territory, Aliaska, Northern Russia, and Siberia.

Hides—The Pampas, Russia, North Germany, Australia, Cape Colony, East Indies.

Ivory—Africa, India, and Siberia (fossil ivory).

Oils—Whale oils, from the Greenland and South seas; seal oil, from Newfoundland, Greenland, and Labrador; cod-liver oil, from Britain, Norway, and Newfoundland.

Ostrich Feathers—Africa generally, and Arabia.

Pearls—Ceylon, Persian Gulf, Coromandel Coast, Panama (South America), and St. Margarita (West Indies).

Silk—China, Italy, Turkey, Greece.

Tallow—Russia, North and South America, India.

Wools—Australia, South Africa, East Indies, South America, Germany.

EXERCISES.

Write out lists of the principal animals of each zone, and give the distinguishing characteristics of its animal life. Name animals peculiar to certain regions, and representative and transferred species, besides those in the text. Draw a chart of the world, and lay down in their respective habitats all the animals mentioned in the text.

CHAPTER IX.

MANKIND.

General Distribution—Races of Men.

83. General Distribution.—Man is the only animal capable of adapting himself to all climates, and hence few regions have been discovered of which he is not an inhabitant. "Under the scorching rays of a tropical sun, upon the banks of the Senegal, the human body supports

a heat which causes spirits of wine to boil; and in the polar regions of North-Eastern Asia, it resists a cold which freezes mercury." Unlike plants and the inferior animals, which are most highly developed within the Tropics, and degenerate towards the Poles, man's noblest type is found in the Temperate Zones. The lowest and most miserable tribes, physically and intellectually, are found occupying the extremities of the continents. Such are the Esquimaux in Arctic North America, the Samoiedes of Arctic Asia, the Fuegians of South America, the Hottentots and Bosjesmen of South Africa, and the aborigines of Australia. But to this there are several important exceptions—the Patagonians, the tallest race known; the Caffres, a bold and warlike people; and the Maoris of New Zealand, a brave, handsome, and intelligent race.

Food.—Within the Tropics man lives chiefly upon vegetables; in the Polar regions, exclusively upon animal food—chiefly fish; and in the Temperate Zones, upon a mixed animal and vegetable diet. But the race is not distributed according to Zones or latitudinal limits.

84. Races of Men.—Though all of one species, mankind have been divided into many varieties, differing chiefly in complexion, feature, form of skull, hair, etc., but also in civilization, language, and religion. The following are the chief varieties :—

I.—Caucasian Race.—**Characteristics.**—Fair complexion, flowing hair, ample beard, oval head, regular features.

Distribution.—It is dispersed over the south-west of Asia, the north and north-east of Africa, and nearly all Europe. It has also, within the last three centuries, extended largely from Europe over North and South America, South Africa, Australia, and New Zealand.

Branches.—The Hindoo, Persian, Arab, Circassian, Sclavonic, Teutonic, and Celtic.

It is termed Caucasian, from the Caucasian Mountains —the surrounding region being (erroneously) supposed to have been the original seat of the race. It is also (and properly) termed Indo-European, as it extends over India and Europe, from the Ganges to Iceland.

II. — Mongolian Race. — **Characteristics.** — Complexion tawny or olive-yellow, hair coarse and straight, beard scanty, head square-shaped, face broad and flat, cheek-bones high, and small black eyes obliquely set.

Distribution.—It extends over all Central and Eastern Asia, and the whole Arctic sea-board of the Old World and the New.

1. Caucasian.

2. Mongolian.

3. Negro (pure type).

4. Malayan.

5. Otto Indian of North America.

CHIEF VARIETIES OF MANKIND.

Branches.—The Chinese, Burmese, Siamese, and neighbouring nations, Japanese, Tibetans, Tartars, Turks,

the Samoiedes, and other tribes of Siberia. In Europe the Turks proper, the Magyars of Hungary, the Finns and Lapps of Northern Russia, and the Esquimaux of Arctic America, are Mongolians.

III.—Negro or Ethiopic Race.—**Characteristics.**—Skin black, hair short and woolly, skull narrow, forehead slanting, cheek-bones high, nose broad and flat, thick lips, and projecting jaws. It is the lowest type, approaching nearest the gorilla and monkey.

Distribution.—It occupies the whole of Africa south of the Great Desert; but the Hottentots and Caffres are not true negroes. Its most typical form is found on the low unhealthy plains and river-deltas of the west coast. The Gallas, Nubians, and Copts of the Nile Valley are the most intelligent, are of a dark-brown colour, and approximate physically and intellectually to the white race, with which they may form a link of connection. Negroes exist largely in America, especially in the United States, West Indies, and Brazil, having been originally conveyed thither as slaves.

The Hottentots are more akin to the Mongolians; having broad foreheads, high cheek-bones, oblique eyes, and a dirty olive-coloured complexion. "The orbits of the eyes are wide and distant from each other, and the face is remarkable for ugliness. The Kaffir (or Caffre) races are a tall, well-made, and generally handsome people, of a dark-brown or bronze colour, and hair in short woolly tufts."

Minor Varieties.—(1) The **Malays**, a form of the Mongolian Race, occupy Malaysia, Australasia, and Polynesia. They are subdivided into—(*a*) **Malays proper**, in Madagascar, Malaysia, and Polynesia; (*b*) **Papuan** or **Oceanic Negroes**, of Australia, New Guinea, New Hebrides, and Feejee Islands—the former of a brown colour, the latter dark, and approaching the Negro type; and (*c*) the **Maoris** of New Zealand.

(2) **American or Red Indians**, the aborigines of North and South America—copper-coloured, with hair lank and black, aquiline nose, and tall, slender figure. They are also a variety of the Mongolian Race.

Colour.—The Caucasians are white, the Mongolians yellow, the Negroes black, the Malays brown, and the Americans red. The colour is due to the presence of a pigment which fills the cells that lie between the epidermis, or outer skin, and the cutis, or second skin, and which, in the case of the white man, are entirely empty. Summer freckles are due to the same cause. But the colour is greatly modified in the case of tribes occupying high and dry plateaux or highland regions, and is comparatively white.

Numbers.—The Caucasians number about 500,000,000, the Mongolians 490,000,000, the Negroes (including Papuans), 100,000,000, the Malays 60,000,000, and the American Indians 16,000,000.

85. Civilization.—The Caucasian race is the most civilized—the most eminent nations of ancient and modern times having sprung from it. The Mongolians are inferior to them intellectually and morally; their civilization, most advanced among the Chinese and Japanese, is of a stationary character. The Americans have also remained stationary, and are now fast disappearing before the white man. The Negro is the lowest of the three great races. He has always remained in a state of barbarism and slavery to the whites. The Malays proper are a hardy and enterprising race; but the natives of Australia, miserable and stunted, occupy the lowest place in the scale of humanity.

POPULATION OF THE GLOBE.

		Average per sq. mile.
Europe,	282,000,000	73 persons.
Asia,	711,000,000	40 ,,
Africa,	130,000,000	11 ,,
North America,	50,000,000	6 ,,
South America,	22,000,000	3·5 ,,
Oceania,	20,000,000	4·5 ,,
	1,215,000,000	

Density of Population.

	Per sq. m.		Per sq. m.
Bermuda,	477	Massachusetts (U. S.),	157
Belgium,	438	United States, generally,	11·3
China proper,	288	Iceland and Faröe Isles,	1·8
Netherlands,	275	Basin of Amazon,	1 per 10 sq. m.
Great Britain & Ireland,	245	Patagonia,	8 per 100 sq. m.
Japan,	233	Greenland,	1 ,,

Summary of Religions.

Roman Catholics,	185,000,000		
Protestants,	95,000,000	Christians,	355,000,000
Greek Church,	75,000,000		
Jews,			7,000,000
Mohammedans,			120,000,000
Hindoos,	120,000,000		
Buddhists,	400,000,000	Heathens,	733,000,000
Other Idolators,	213,000,000		
			1,215,000,000

EXERCISES.

1. Give reasons to account for man's capability of adaptation to all climates. Write out in tabular form the races of men, with their characteristics, distribution, chief sub-divisions, and state of civilization. To which race, and which of its branches, do the people of Great Britain and Ireland belong? Lay down on a map of the world the Distribution of the Races of Men.

SPECIMEN EXAMINATION PAPERS.

General Instructions.

You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to, the paper will be cancelled.

In all cases the number of the question must be placed before the answer on the worked paper.

Three hours are allowed for this paper.

FIRST STAGE OR ELEMENTARY EXAMINATION

Instructions.

You are only permitted to attempt eight questions.

You must attempt the first three questions on the paper. The remaining five you may select from any part of the paper.

The value attached to each of the first three questions is 10 marks. The value of each of the remaining questions is 14 marks. But a full and correct answer to an easy question will in all cases secure a larger number of marks, than an incomplete or inexact answer to a more difficult one.

I.

1 What is the figure of the earth? What is the equator? And what are the poles?

2. What is the proportion of the earth's surface that is covered by water? Is there more water north or south of the equator?

3. What are the two principal rivers of India? From what mountain chain do they originate? Into what seas do they enter? And with what ocean do these seas communicate?

4. What is the position of the Alpine mountain system in Europe? What are the principal spurs or branches proceeding from it? What is the direction of each?

5. What is the general form of the bed of the Atlantic between Ireland and Newfoundland? What is the greatest depth of water in this part of the ocean?

6. Mention the prevalent winds experienced by a ship proceeding from London to the West Indies.

7. What is a cloud? What are the varieties of clouds? What is the relative height of the different groups of clouds?

8. Compare the climates of Ireland and Newfoundland. What are the causes of the difference of climate in these two localities?

9. What is a volcano? What are the substances ejected during an ordinary volcanic eruption?

10. Mention some of the principal food plants, the places whence they were originally obtained, and the parts of the earth where they are chiefly consumed.

11. What is the limit of distribution of monkeys? What are the differences between the four-handed animals of the Old World and America?

12. Compare the native races of men of tropical Africa with those of tropical America.

II.

1. Explain what is meant by longitude. What is the length of a degree of longitude at the equator and in the latitude of London?

2. What are the chief promontories of Asia? In what direction do they point? What is the form of Africa? (a diagram if preferred).

3. Name (*a*) a large inland sea communicating with the ocean, (*b*) a salt lake, (*c*) an important fresh-water lake. State in each case the geographical position.

4. What is the origin of rain? Why is rain distributed unequally over the earth? Mention certain districts without rain in ordinary years.

5. What is dew? Mention the conditions of the air favourable and unfavourable for its deposit. What is the season of heaviest dew in the British Islands?

6. Name one of the great rivers in the Old World. State the position of its chief sources, and their height above the sea, the names of the chief tributaries, the circumstances under which the river reaches the sea, and the countries it passes through.

7. Explain the difference between the tidal wave in the open Atlantic and the tidal wave advancing up the English Channel.

8. What is the air? What are wind storms; and what is the difference between periodical and permanent winds?

9. Where is Mount Hecla? Give proof of the existence of subterranean communication between Etna and Vesuvius. Men-

tion another European active volcano (not in Italy) and its position.

10. Mention two food-plants and two tribes of animals all characteristic of the tropics. Mention corresponding plants and animals in temperate climates.

11. Point out an essential difference between the monkeys of the Old and New Worlds. To which of the six principal divisions of the land are monkeys now limited? What are the characteristic carnivora of Asia, and what the genera that most nearly represent them in South America and Australia?

12. What is the geographical home of the negro? What are the two principal varieties of the negro in South Africa? Describe some of the marked peculiarities of the true negro and these two varieties.

III.

1. What is meant by Physical Geography? How does Physical Geography differ from Descriptive Geography and from Geology?

2. Explain the meaning of the following terms, and give an example of each: (*a*) Mountain system, (*b*) River system.

3. What is a volcano? Where are the principal groups of volcanoes? Name the chief volcanoes of Europe.

4. What are the three great oceans? Do the great oceans open into each other, and, if so, by what channels? What are the largest islands, and where are they situated?

5. Explain in what way a broken and irregular coast-line may be an advantage to a country. Mention an island remarkable for its irregularity of coast. Mention some large tract of land having an unbroken coast-line.

6. Give an account of the whole course of some important river, mentioning its sources, its chief tributaries, its lakes and waterfalls, and the circumstances under which it reaches the sea.

7. What is a glacier? Where are the chief glaciers of Europe?

8. Describe the trade-winds, and explain their cause.

9. In what countries near the sea-level, and within what altitudes within the tropics, do pines grow freely? What food plants are most common in the pine region?

10. In what countries are humming-birds found? Within what limits are birds of brilliant plumage for the most part confined? To what countries is the ostrich limited?

11. What proof is there that the human race existed on the earth at a time when the climate was very different from that which now prevails?

12. Mention some of the more striking changes produced in Australia on the distribution of quadrupeds since the country has become partially occupied by civilized races.

INDEX.

WILLIAM COLLINS AND CO., PRINTERS, GLASGOW.

LD 21A–20m-7,'74
(S52L)

General Library
University of California
Berkeley

VIII.

THE ATLAS OF SCRIPTURE GEOGRAPHY.

16 Maps, with Questions on each Map. Small 4to, flexible, cloth, 75 cents.

1. The Ancient World.
2. Countries mentioned in the Scriptures.
3. Canaan, in the time of the Patriarchs.
4. Journeying of the Israelites.
5. Canaan as divided amongst the Tribes.
6. Dominions of David and Solomon.
7. Countries of the Jewish Captivities.
8. Palestine in the time of Christ.
9. Modern Palestine.
10. Physical Map of Palestine.
11. Journeys of the Apostle Paul.
12. The distribution of the Prevailing Religions of the World.
13. The Tabernacle, Camp, etc.
14. Solomon'sTemple and Herod'sTemple.
15. Ancient Jerusalem.
16. Modern Jerusalem.

IX.

THE HANDBOOK OF SCRIPTURE GEOGRAPHY.

16 Maps and Plans, with Questions and Answers on each map. 16mo, cloth extra.

X.

THE

Consi

Consi

Cons

"T
engra
Evening Mail.

"The Maps are well executed, and the work is most convenient for reference."—*N. Y. Tribune.*

"The Maps of the CLASSICAL ATLAS are of exquisite clearness and beauty."—*Christian Union.*

"The Maps of the PORTABLE ATLAS are excellent, and the series to which it belongs contains the best low-priced atlases in the market."—*N. Y. Evening Mail.*

"The SCRIPTURE ATLAS is full, accurate, clear, and portable."—*Christian Union.*

"We refer to it with edification and delight."—*Rhode Island Schoolmaster.*

"A very complete and compendious work, apparently accurate and in beautiful style."—*Rev. Stephen H. Tyng, D.D.*

G. P. PUTNAM'S SONS,
4th Avenue and 23rd Street, New York.